

Operation and Maintenance Manual

1106E Engine

VK[(Engine)]

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Perkins cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Perkins is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Perkins dealers have the most current information available.



When replacement parts are required for this product Perkins recommends using Perkins replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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Foreword

Literature Information

This manual contains safety, operation instructions, lubrication and maintenance information. This manual should be stored in or near the engine area in a literature holder or literature storage area. Read, study and keep it with the literature and engine information.

English is the primary language for all Perkins publications. The English used facilitates translation and consistency in electronic media delivery.

Some photographs or illustrations in this manual show details or attachments that may be different from your engine. Guards and covers may have been removed for illustrative purposes. Continuing improvement and advancement of product design may have caused changes to your engine which are not included in this manual. Whenever a question arises regarding your engine, or this manual, please consult with your Perkins dealer for the latest available information.

Safety

This safety section lists basic safety precautions. In addition, this section identifies hazardous, warning situations. Read and understand the basic precautions listed in the safety section before operating or performing lubrication, maintenance and repair on this product.

Operation

Operating techniques outlined in this manual are basic. They assist with developing the skills and techniques required to operate the engine more efficiently and economically. Skill and techniques develop as the operator gains knowledge of the engine and its capabilities.

The operation section is a reference for operators. Photographs and illustrations guide the operator through procedures of inspecting, starting, operating and stopping the engine. This section also includes a discussion of electronic diagnostic information.

Maintenance

The maintenance section is a guide to engine care. The illustrated, step-by-step instructions are grouped by fuel consumption, service hours and/or calendar time maintenance intervals. Items in the maintenance schedule are referenced to detailed instructions that follow.

Use fuel consumption or service hours to determine intervals. Calendar intervals shown (daily, annually, etc.) may be used instead of service meter intervals if they provide more convenient schedules and approximate the indicated service meter reading.

Recommended service should be performed at the appropriate intervals as indicated in the Maintenance Interval Schedule. The actual operating environment of the engine also governs the Maintenance Interval Schedule. Therefore, under extremely severe, dusty, wet or freezing cold operating conditions, more frequent lubrication and maintenance than is specified in the Maintenance Interval Schedule may be necessary.

The maintenance schedule items are organized for a preventive maintenance management program. If the preventive maintenance program is followed, a periodic tune-up is not required. The implementation of a preventive maintenance management program should minimize operating costs through cost avoidances resulting from reductions in unscheduled downtime and failures.

Maintenance Intervals

Perform maintenance on items at multiples of the original requirement. Each level and/or individual items in each level should be shifted ahead or back depending upon your specific maintenance practices, operation and application. We recommend that the maintenance schedules be reproduced and displayed near the engine as a convenient reminder. We also recommend that a maintenance record be maintained as part of the engine's permanent record.

See the section in the Operation and Maintenance Manual, "Maintenance Records" for information regarding documents that are generally accepted as proof of maintenance or repair. Your authorized Perkins dealer can assist you in adjusting your maintenance schedule to meet the needs of your operating environment.

Overhaul

Major engine overhaul details are not covered in the Operation and Maintenance Manual except for the interval and the maintenance items in that interval. Major repairs are best left to trained personnel or an authorized Perkins dealer. Your Perkins dealer offers a variety of options regarding overhaul programs. If you experience a major engine failure, there are also numerous after failure overhaul options available from your Perkins dealer. Consult with your dealer for information regarding these options.

California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Battery posts, terminals and related accessories contain lead and lead compounds. **Wash hands after handling.**

Safety Section

Safety Signs and Labels

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There may be several specific warning signs on an engine. The exact location of the hazards and the description of the hazards are reviewed in this section. Please become familiar with all warning signs.

Ensure that all of the warning signs are legible. Clean the warning signs or replace the warning signs if the words cannot be read or if the pictures are not visible. When the warning signs are cleaned, use a cloth, water, and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the warning signs. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the warning signs. The warning signs that are loosened could drop off of the engine.

Replace any damaged warning signs or missing warning signs. If a warning sign is attached to a part of the engine that is replaced, install a new warning sign on the replacement part. Perkins dealers or Perkins distributors can provide new warning signs.

Do not work on the engine and do not operate the engine unless the instructions and warnings in the Operation and Maintenance Manual are understood. Proper care is your responsibility. Failure to follow the instructions or failure to heed the warnings could result in injury or in death.

The warning labels that may be found on the engine are illustrated and described.

Ether

The warning label for ether is located on the top, the front, the rear, or the side of the engine.



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Never spray Ether starting aids into the air inlet.

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General Hazard Information

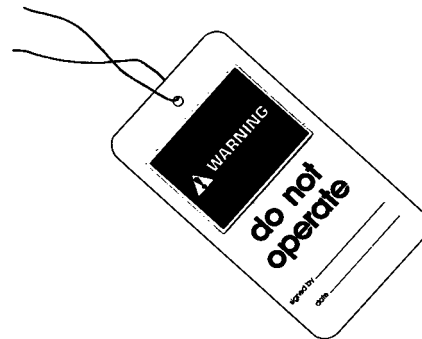


Illustration 1

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Attach a "Do Not Operate" warning tag or a similar warning tag to the start switch or to the controls before you service the equipment or before you repair the equipment.

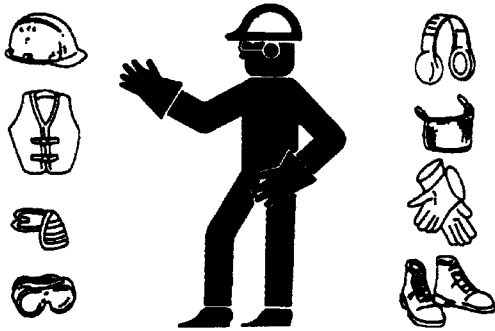


Illustration 2

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Wear a hard hat, protective glasses, and other protective equipment, as required.

Do not wear loose clothing or jewelry that can snag on controls or on other parts of the engine.

Make sure that all protective guards and all covers are secured in place on the engine.

Keep the engine free from foreign material. Remove debris, oil, tools, and other items from the deck, from walkways, and from steps.

Never put maintenance fluids into glass containers. Drain all liquids into a suitable container.

Obey all local regulations for the disposal of liquids.

Use all cleaning solutions with care. Report all necessary repairs.

Do not allow unauthorized personnel on the equipment.

Unless you are instructed otherwise, perform maintenance on the engine with the equipment in the servicing position. Refer to the OEM information for the procedure for placing the equipment in the servicing position.

Pressure Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out. This could result in personal injury.

When pressurized air and/or water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield.

The maximum air pressure for cleaning purposes must be below 205 kPa (30 psi). The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

Fluid Penetration

Pressure can be trapped in the hydraulic circuit long after the engine has been stopped. The pressure can cause hydraulic fluid or items such as pipe plugs to escape rapidly if the pressure is not relieved correctly.

Do not remove any hydraulic components or parts until pressure has been relieved or personal injury may occur. Do not disassemble any hydraulic components or parts until pressure has been relieved or personal injury may occur. Refer to the OEM information for any procedures that are required to relieve the hydraulic pressure.

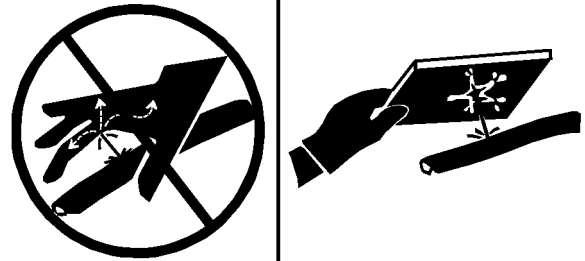


Illustration 3

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Always use a board or cardboard when you check for a leak. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Containing Fluid Spillage

Care must be taken in order to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the engine. Make provision to collect the fluid with a suitable container before any compartment is opened or before any component is disassembled.

- Only use the tools that are suitable for collecting fluids and equipment that is suitable for collecting fluids.
- Only use the tools that are suitable for containing fluids and equipment that is suitable for containing fluids.

Obey all local regulations for the disposal of liquids.

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Burn Prevention

Do not touch any part of an operating engine. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the hydraulic system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings or related items are disconnected.

Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check the coolant level after the engine has stopped and the engine has been allowed to cool.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly in order to relieve pressure.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

Oils

Hot oil and hot lubricating components can cause personal injury. Do not allow hot oil to contact the skin. Also, do not allow hot components to contact the skin.

Batteries

Electrolyte is an acid. Electrolyte can cause personal injury. Do not allow electrolyte to contact the skin or the eyes. Always wear protective glasses for servicing batteries. Wash hands after touching the batteries and connectors. Use of gloves is recommended.

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Fire Prevention and Explosion Prevention



Illustration 4

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All fuels, most lubricants, and some coolant mixtures are flammable.

Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. Fire may cause personal injury and property damage.

A flash fire may result if the covers for the engine crankcase are removed within fifteen minutes after an emergency shutdown.

Determine whether the engine will be operated in an environment that allows combustible gases to be drawn into the air inlet system. These gases could cause the engine to overspeed. Personal injury, property damage, or engine damage could result.

If the application involves the presence of combustible gases, consult your Perkins dealer and/or your Perkins distributor for additional information about suitable protection devices.

Remove all flammable materials such as fuel, oil, and debris from the engine. Do not allow any flammable materials to accumulate on the engine.

Store fuels and lubricants in properly marked containers away from unauthorized persons. Store oily rags and any flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.

Do not expose the engine to any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil or fuel spray in case of a line, a tube, or a seal failure. Exhaust shields must be installed correctly.

Do not weld on lines or tanks that contain flammable fluids. Do not flame cut lines or tanks that contain flammable fluid. Clean any such lines or tanks thoroughly with a nonflammable solvent prior to welding or flame cutting.

Wiring must be kept in good condition. All electrical wires must be properly routed and securely attached. Check all electrical wires daily. Repair any wires that are loose or frayed before you operate the engine. Clean all electrical connections and tighten all electrical connections.

Eliminate all wiring that is unattached or unnecessary. Do not use any wires or cables that are smaller than the recommended gauge. Do not bypass any fuses and/or circuit breakers.

Arcing or sparking could cause a fire. Secure connections, recommended wiring, and properly maintained battery cables will help to prevent arcing or sparking.

Inspect all lines and hoses for wear or for deterioration. The hoses must be properly routed. The lines and hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

Oil filters and fuel filters must be properly installed. The filter housings must be tightened to the proper torque.



Illustration 5

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Use caution when you are refueling an engine. Do not smoke while you are refueling an engine. Do not refuel an engine near open flames or sparks. Always stop the engine before refueling.

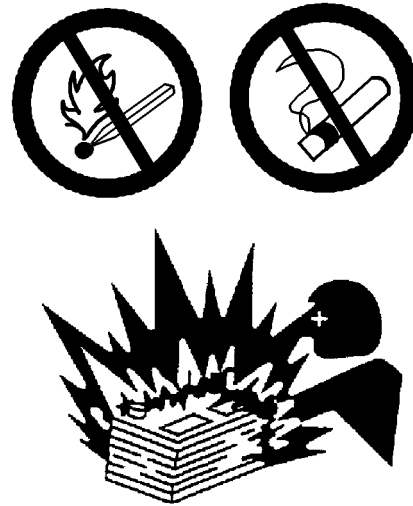


Illustration 6

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Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter or a hydrometer.

Improper jumper cable connections can cause an explosion that can result in injury. Refer to the Operation Section of this manual for specific instructions.

Do not charge a frozen battery. This may cause an explosion.

The batteries must be kept clean. The covers (if equipped) must be kept on the cells. Use the recommended cables, connections, and battery box covers when the engine is operated.

Fire Extinguisher

Make sure that a fire extinguisher is available. Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Obey the recommendations on the instruction plate.

Lines, Tubes and Hoses

Do not bend high pressure lines. Do not strike high pressure lines. Do not install any lines that are bent or damaged.

Repair any lines that are loose or damaged. Leaks can cause fires. Consult your Perkins dealer for repair or for replacement parts.

Check lines, tubes and hoses carefully. Do not use your bare hand to check for leaks. Use a board or cardboard to check for leaks. Tighten all connections to the recommended torque.

Replace the parts if any of the following conditions are present:

- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are ballooning.
- Flexible part of the hoses are kinked.
- Outer covers have embedded armoring.
- End fittings are displaced.

Make sure that all clamps, guards, and heat shields are installed correctly. During engine operation, this will help to prevent vibration, rubbing against other parts, and excessive heat.

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Crushing Prevention and Cutting Prevention

Support the component properly when work beneath the component is performed.

Unless other maintenance instructions are provided, never attempt adjustments while the engine is running.

Stay clear of all rotating parts and of all moving parts. Leave the guards in place until maintenance is performed. After the maintenance is performed, reinstall the guards.

Keep objects away from moving fan blades. The fan blades will throw objects or cut objects.

When objects are struck, wear protective glasses in order to avoid injury to the eyes.

Chips or other debris may fly off objects when objects are struck. Before objects are struck, ensure that no one will be injured by flying debris.

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Mounting and Dismounting

Inspect the steps, the handholds, and the work area before mounting the engine. Keep these items clean and keep these items in good repair.

Mount the engine and dismount the engine only at locations that have steps and/or handholds. Do not climb on the engine, and do not jump off the engine.

Face the engine in order to mount the engine or dismount the engine. Maintain a three-point contact with the steps and handholds. Use two feet and one hand or use one foot and two hands. Do not use any controls as handholds.

Do not stand on components which cannot support your weight. Use an adequate ladder or use a work platform. Secure the climbing equipment so that the equipment will not move.

Do not carry tools or supplies when you mount the engine or when you dismount the engine. Use a hand line to raise and lower tools or supplies.

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Before Starting Engine

NOTICE

For initial start-up of a new or rebuilt engine, and for start-up of an engine that has been serviced, make provision to shut the engine off should an overspeed occur. This may be accomplished by shutting off the air and/or fuel supply to the engine.

Overspeed shutdown should occur automatically. If automatic shutdown does not occur, press the emergency stop button in order to cut the fuel and/or air to the engine.

Inspect the engine for potential hazards.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

If equipped, ensure that the lighting system for the engine is suitable for the conditions. Ensure that all lights work properly, if equipped.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided in order to help prevent personal injury. The circuits are also provided in order to help prevent engine damage.

See the Service Manual for repairs and for adjustments.

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Engine Starting

WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

If a warning tag is attached to the engine start switch or to the controls, DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Start the engine from the operator's compartment or from the engine start switch.

Always start the engine according to the procedure that is described in the Operation and Maintenance Manual, "Engine Starting" topic in the Operation Section. Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working properly, check the water temperature gauge and the oil temperature gauge during the heater operation.

Engine exhaust contains products of combustion which can be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

Note: The engine is equipped with an automatic device for cold starting for normal conditions of operation. If the engine will be operated in very cold conditions, then an extra cold starting aid may be required. Normally, the engine will be equipped with the correct type of starting aid for your region of operation.

The 1106 electronic engine is equipped with an air inlet heater starting aid as standard equipment.

The air inlet heater starting aid is a device that uses electricity to ignite a metered amount of distillate diesel fuel in the air intake manifold. This will increase the air intake temperature.

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Engine Stopping

Stop the engine according to the procedure in the Operation and Maintenance Manual, "Engine Stopping (Operation Section)" in order to avoid overheating of the engine and accelerated wear of the engine components.

Use the Emergency Stop Button (if equipped) ONLY in an emergency situation. Do not use the Emergency Stop Button for normal engine stopping. After an emergency stop, DO NOT start the engine until the problem that caused the emergency stop has been corrected.

Stop the engine if an overspeed condition occurs during the initial start-up of a new engine or an engine that has been overhauled. This may be accomplished by shutting off the fuel supply to the engine and/or shutting off the air supply to the engine.

To stop an electronically controlled engine, cut the power to the engine.

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Electrical System

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operating. A spark can cause the combustible gases that are produced by some batteries to ignite.

To help prevent sparks from igniting combustible gases that are produced by some batteries, the negative “-” jump start cable should be connected last from the external power source to the negative “-” terminal of the starting motor. If the starting motor is not equipped with a negative “-” terminal, connect the jump start cable to the engine block.

Check the electrical wires daily for wires that are loose or frayed. Tighten all loose electrical wires before the engine is started. Repair all frayed electrical wires before the engine is started. See the Operation and Maintenance Manual for specific starting instructions.

Grounding Practices

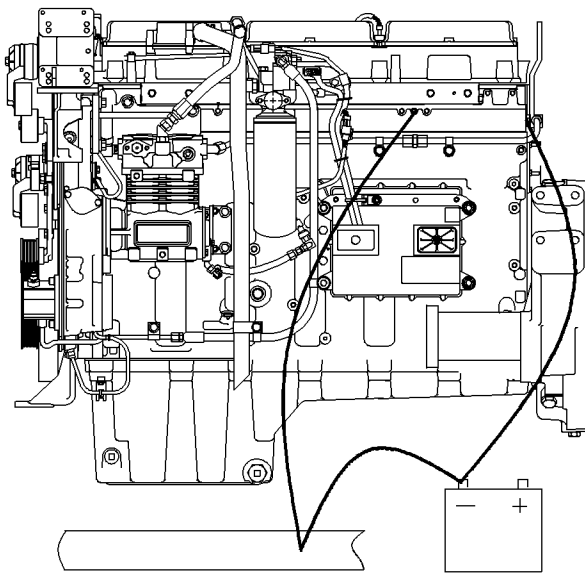


Illustration 7

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Typical example

Alternate Grounding Stud To Battery Ground

Proper grounding for the engine electrical system is necessary for optimum engine performance and reliability. Improper grounding will result in uncontrolled electrical circuit paths and in unreliable electrical circuit paths.

Uncontrolled electrical circuit paths can result in damage to main bearings, to crankshaft bearing journal surfaces, and to aluminum components.

Engines that are installed without engine-to-frame ground straps can be damaged by electrical discharge.

To ensure that the engine and the engine electrical systems function properly, an engine-to-frame ground strap with a direct path to the battery must be used. This path may be provided by way of a direct engine ground to the frame.

All grounds should be tight and free of corrosion. The engine alternator must be grounded to the negative “-” battery terminal with a wire that is adequate to handle the full charging current of the alternator.

The power supply connections and the ground connections for the engine electronics should always be from the battery.

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Engine Electronics

WARNING

Tampering with the electronic system installation or the OEM wiring installation can be dangerous and could result in personal injury or death and/or engine damage.

This engine has a comprehensive, programmable Engine Monitoring System. The Electronic Control Module (ECM) has the ability to monitor the engine operating conditions. If any of the engine parameters extend outside an allowable range, the ECM will initiate an immediate action.

The following actions are available for engine monitoring control: WARNING, DERATE, and SHUTDOWN. These engine monitoring modes have the ability to limit engine speed and/or the engine power.

- Engine Coolant Temperature
- Engine Oil Pressure
- Engine Speed
- Fuel Temperature
- Intake Manifold Air Temperature
- System Voltage

The Engine Monitoring package can vary for different engine models and different engine applications. However, the monitoring system and the engine monitoring control will be similar for all engines.

Note: Many of the engine control systems and display modules that are available for Perkins Engines will work in unison with the Engine Monitoring System. Together, the two controls will provide the engine monitoring function for the specific engine application. Refer to the Electronic Troubleshooting Manual for more information on the Engine Monitoring System.

Product Information Section

General Information

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Welding on Engines with Electronic Controls

NOTICE

Proper welding procedures are necessary in order to avoid damage to the engine's ECM, sensors, and associated components. When possible, remove the component from the unit and then weld the component. If removal of the component is not possible, the following procedure must be followed when you weld with a unit that is equipped with an Electronic Engine. The following procedure is considered to be the safest procedure to weld a component. This procedure should provide a minimum risk of damage to electronic components.

NOTICE

Do not ground the welder to electrical components such as the ECM or sensors. Improper grounding can cause damage to the drive train bearings, hydraulic components, electrical components, and other components.

Clamp the ground cable from the welder to the component that will be welded. Place the clamp as close as possible to the weld. This will help reduce the possibility of damage.

1. Stop the engine. Turn the switched power to the OFF position.
2. Disconnect the negative battery cable from the battery. If a battery disconnect switch is provided, open the switch.
3. Disconnect the J1/P1 connectors from the ECM. Move the harness to a position that will not allow the harness to accidentally move back and make contact with any of the ECM pins.

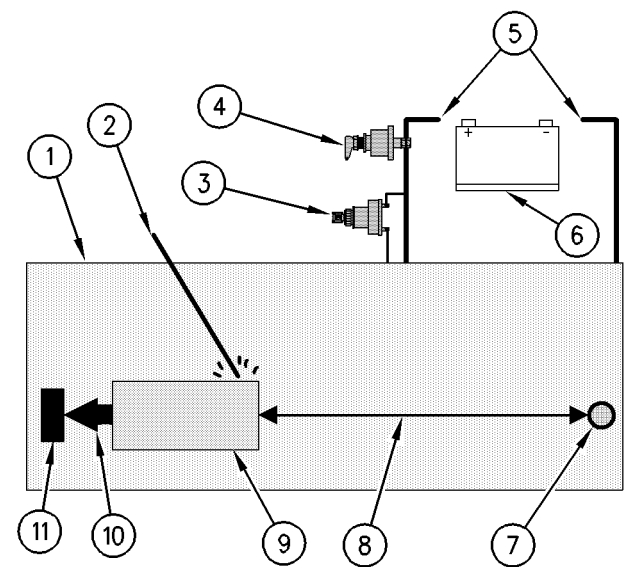


Illustration 8

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Use the example above. The current flow from the welder to the ground clamp of the welder will not cause damage to any associated components.

- (1) Engine
- (2) Welding rod
- (3) Keyswitch in the OFF position
- (4) Battery disconnect switch in the open position
- (5) Disconnected battery cables
- (6) Battery
- (7) Electrical/Electronic component
- (8) Maximum distance between the component that is being welded and any electrical/electronic component
- (9) The component that is being welded
- (10) Current path of the welder
- (11) Ground clamp for the welder

4. Connect the welding ground cable directly to the part that will be welded. Place the ground cable as close as possible to the weld in order to reduce the possibility of welding current damage to bearings, hydraulic components, electrical components, and ground straps.

Note: If electrical/electronic components are used as a ground for the welder, or electrical/electronic components are located between the welder ground and the weld, current flow from the welder could severely damage the component.

5. Protect the wiring harness from welding debris and spatter.
6. Use standard welding practices to weld the materials.

Model Views

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Model View Illustrations

1106 Engine Views

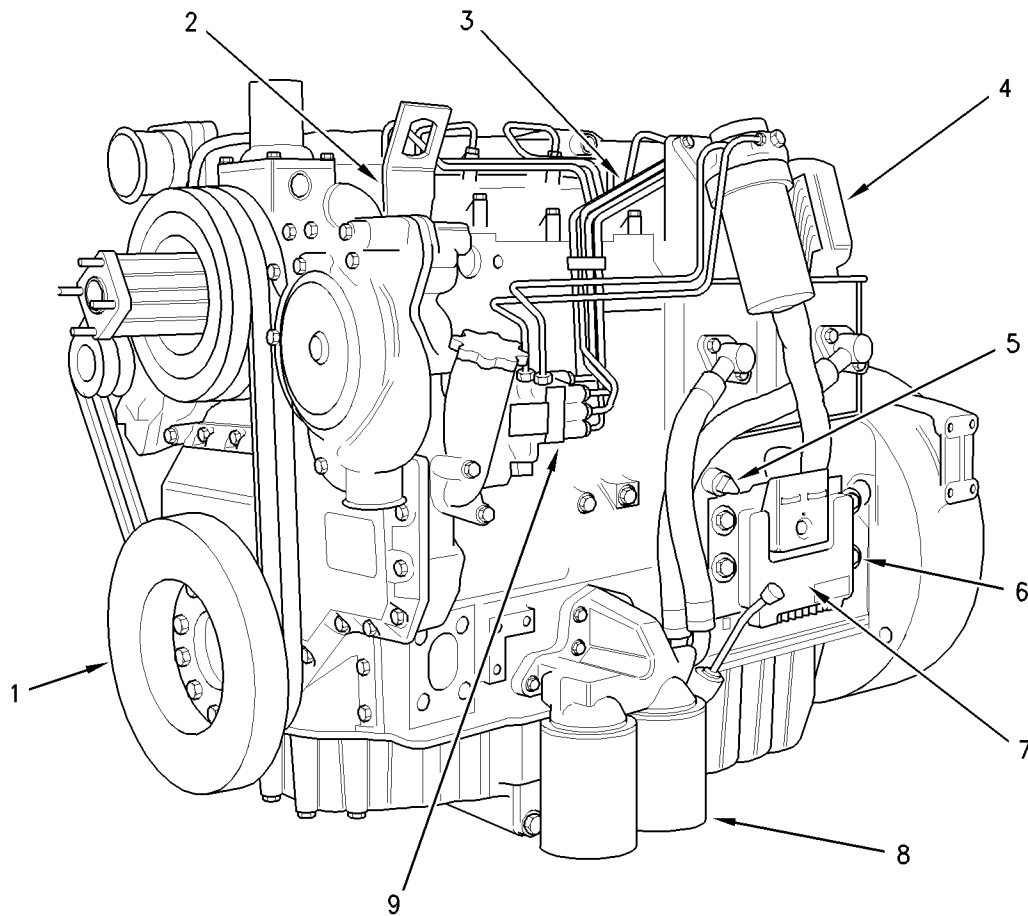


Illustration 9

g00888100

Left side view of the 1106 engine

Typical example of the 1106 engine

- (1) Crankshaft pulley
- (2) Engine coolant temperature sensor
- (3) Fuel lines

- (4) Machine interface connector (MIC)
- (5) Engine oil pressure sensor
- (6) Speed/timing sensor

- (7) Electronic control module (ECM)
- (8) Engine oil filter
- (9) Electronic fuel injection pump

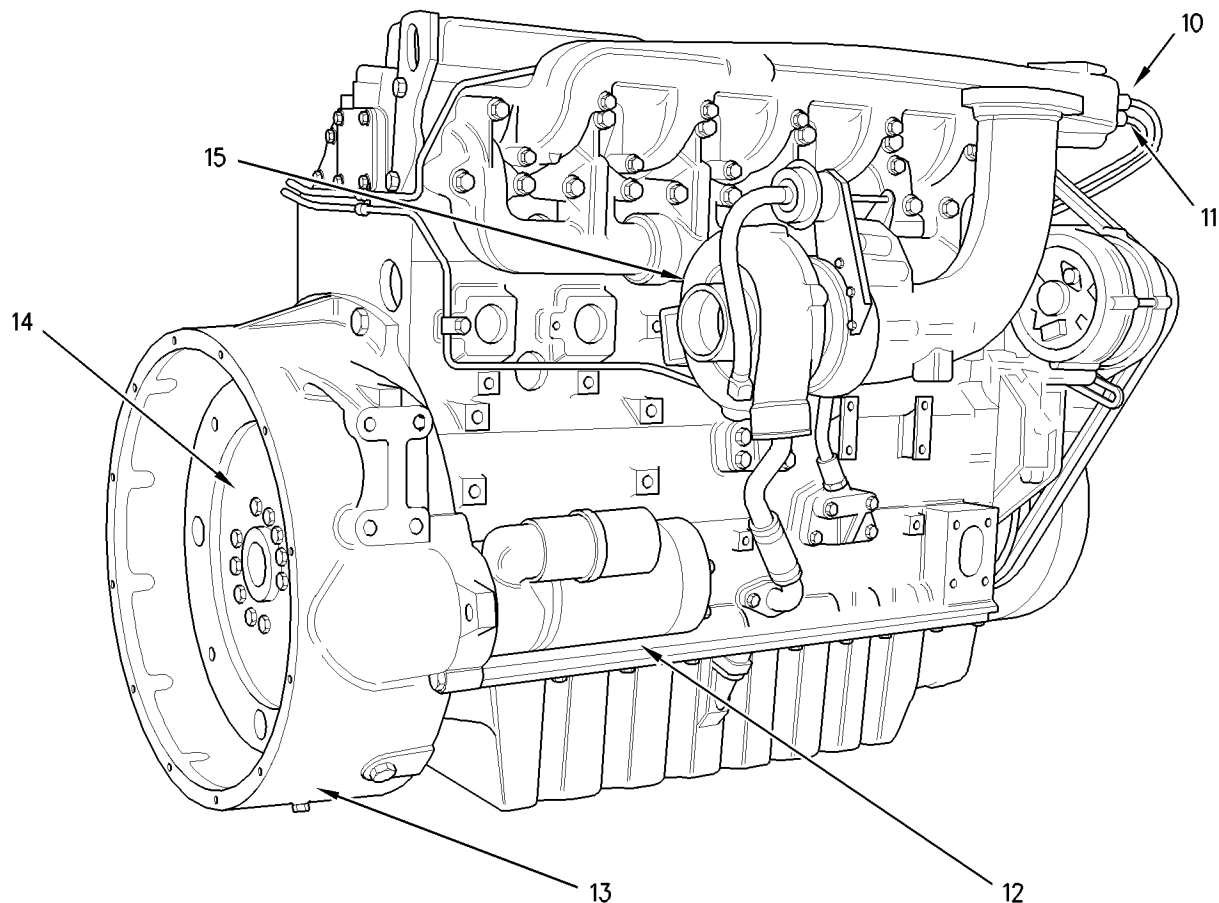


Illustration 10

g00888106

Right side view of the 1106 engine

Typical example of the 1106 engine

(10) Boost pressure sensor

(11) Inlet manifold temperature sensor

(12) Electric starting motor

(13) Flywheel housing

(14) Flywheel

(15) Turbocharger

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Engine Description

The 1106 Electronic Engine is designed for the following applications: machine and industrial mobile equipment. The engine is available in the following types of aspiration:

- Turbocharged aftercooled

Engine Specifications

Note: The front end of the engine is opposite the flywheel end of the engine. The left and the right sides of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.

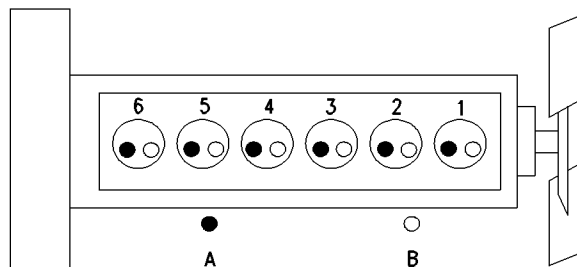


Illustration 11

g00662980

1106 Electronic engine

(A) Exhaust valves

(B) Inlet valves

Table 1

1106 Electronic Engine Specifications	
Operating Range (rpm)	1500 to 2800 ⁽¹⁾
Number of Cylinders	6 In-Line
Bore	100 mm (3.9 inch)
Stroke	127 mm (5.0 inch)
Aspiration	Turbocharged aftercooled
Compression Ratio	TA 17.25:1
Displacement	6 L (365 in ³)
Firing Order	1-5-3-6-2-4
Rotation (flywheel end)	Counterclockwise
Valve Lash Setting (Inlet)	0.20 mm (0.008 inch)
Valve Lash Setting (Exhaust)	0.45 mm (0.018 inch)

⁽¹⁾ The operating rpm is dependent on the engine rating, the application and the configuration of the throttle.

Electronic Engine Features

The Perkins 1106 Electronic Engine is designed with electronic controls. The integral on board computer controls the operation of the engine. Current operating conditions are monitored. The Electronic Control Module (ECM) controls the response of the engine to these conditions and to the demands of the operator. These conditions and operator demands determine the precise control of fuel injection by the ECM. The electronic engine control system provides the following features:

- Engine monitoring
- Engine speed governing
- Cold start strategy

- Automatic air/fuel ratio control
- Torque rise shaping
- Automatic altitude compensation
- Fuel temperature compensation
- Injection timing control
- System diagnostics

For more information on electronic engine features, refer to the Operation and Maintenance Manual, "Features and Controls" topic (Operation Section).

Engine Diagnostics

The engine has built-in diagnostics in order to ensure that all of the components are functioning properly. The operator will be informed of any change to a programmed limit. The operator will be alerted to the condition by a "Stop or Warning" lamp that is mounted on the dashboard. Under certain conditions, the engine horsepower and the vehicle speed may be limited. The electronic service tool may be used to display the diagnostic codes.

There are three types of diagnostic codes: active, logged, and event.

Most of the diagnostic codes are logged and stored in the ECM. For additional information, refer to the Operation and Maintenance Manual, "Engine Diagnostics" topic (Operation Section).

The ECM provides an electronic governor that controls the injector output in order to maintain the desired engine rpm.

Engine Cooling and Lubrication

The cooling system consists of the following components:

- Gear-driven centrifugal water pump
- Water temperature regulators which regulate the engine coolant temperature
- Gear-driven oil pump (gear type)
- Oil cooler

The engine lubricating oil is supplied by a gear type pump. The engine lubricating oil is cooled and the engine lubricating oil is filtered. Bypass valves provide unrestricted flow of lubrication oil to the engine parts when oil viscosity is high. Bypass valves can also provide unrestricted flow of lubrication oil to the engine parts if the oil cooler should become plugged or if the oil filter element should become plugged.

Engine efficiency, efficiency of emission controls, and engine performance depend on adherence to proper operation and maintenance recommendations. Engine performance and efficiency also depend on the use of recommended fuels, lubrication oils, and coolants. Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for more information on maintenance items.

Engine Service Life

Engine efficiency and maximum utilization of engine performance depend on the adherence to proper operation and maintenance recommendations. In addition, use recommended fuels, coolants and lubricants. Use the Operation and Maintenance Manual as a guide for required engine maintenance.

Expected engine life is generally predicted by the average power that is demanded. The average power that is demanded is based on fuel consumption of the engine over a period of time. Reduced hours of operation at full throttle and/or operating at reduced throttle settings result in a lower average power demand. Reduced hours of operation will increase the length of operating time before an engine overhaul is required.

i01891296

Product Identification Information

i01889962

Engine Identification

Perkins engines are identified by a serial number. This number is shown on a serial number plate that is mounted on the left hand side of the engine block.

An example of an engine number is VKU090001H.

VK _____ Type of engine

U _____ Built in the United Kingdom

0900001 _____ Engine Serial Number

H _____ Year of Manufacture

The numbers for fuel setting information for electronic engines are stored within the personality module. These numbers can be read by using the Electronic Service Tool.

Perkins dealers need these numbers in order to determine the components that were included with the engine. This permits accurate identification of replacement part numbers.

Serial Number Plate

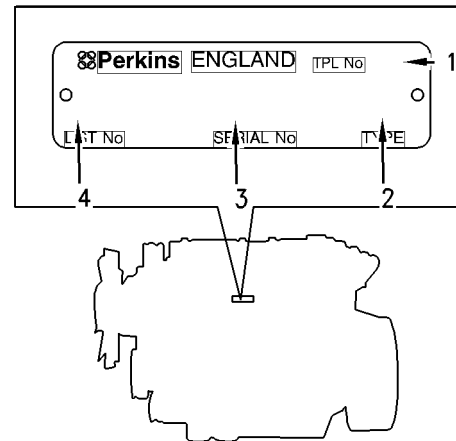


Illustration 12

g00994966

Typical serial number plate

- (1) Temporary Parts List number
- (2) Type
- (3) Serial number
- (4) List number

The Serial Number Plate is located on the left side of the cylinder block behind the high pressure pipes of the Fuel injection pump.

The following information is stamped on the Serial Number Plate: Engine serial number, Model, and Arrangement number.

i01892045

Reference Numbers

Information for the following items may be needed to order parts. Locate the information for your engine. Record the information on the appropriate space. Make a copy of this list for a record. Keep the information for future reference.

Record for Reference

Engine Model _____

Engine Serial No. _____

Engine Low Idle rpm _____

Engine Full Load rpm _____

Primary Fuel Filter No. _____

Water Separator Element No. _____

Secondary Fuel Filter Element No. _____

Lubrication Oil Filter Element No. _____

Auxiliary Oil Filter Element No. _____

Total Lubrication System Capacity _____

Total Cooling System Capacity _____

Air Cleaner Element No. _____

Fan Drive Belt No. _____

Alternator Belt No. _____

i01925933

Emissions Certification Film

A typical example is shown.

		IMPORTANT ENGINE INFORMATION			
ENGINE FAMILY		INITIAL INJECTION TIMING			
ENGINE TYPE		FUEL RATE AT ADVERTISED kW mm ³ /STROKE			
ENGINE NO.		DISPLACEMENT L			96
ADVERTISED kW AT RPM		IDLE RPM	24		
VALVE LASH COLD (INCHES) EXH. INLET					
EMISSION CONTROL SYSTEM		e11•97/68			
SETTINGS ARE TO BE MADE WITH ENGINE AT NORMAL OPERATING TEMPERATURE TRANSMISSION IN NEUTRAL					
THIS ENGINE CONFORMS TO U.S. EPA AND CALIFORNIA REGULATIONS LARGE NON-ROAD COMPRESSION-IGNITION ENGINES					
THIS ENGINE IS CERTIFIED TO OPERATE ON COMMERCIALLY AVAILABLE DIESEL FUEL					
					3181A007

Operation Section

Lifting and Storage

Engine Lifting

i01898037

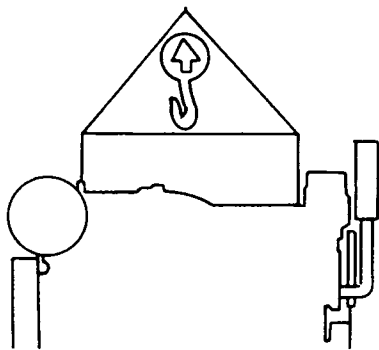


Illustration 14

g00103219

NOTICE

Never bend the eyebolts and the brackets. Only load the eyebolts and the brackets under tension. Remember that the capacity of an eyebolt is less as the angle between the supporting members and the object becomes less than 90 degrees.

When it is necessary to remove a component at an angle, only use a link bracket that is properly rated for the weight.

Use a hoist to remove heavy components. Use an adjustable lifting beam to lift the engine. All supporting members (chains and cables) should be parallel to each other. The chains and cables should be perpendicular to the top of the object that is being lifted.

Some removals require lifting the fixtures in order to obtain proper balance and safety.

To remove the engine ONLY, use the lifting eyes that are on the engine.

Lifting eyes are designed and installed for specific engine arrangements. Alterations to the lifting eyes and/or the engine make the lifting eyes and the lifting fixtures obsolete. If alterations are made, ensure that proper lifting devices are provided. Consult your Perkins dealer for information regarding fixtures for proper engine lifting.

Engine Storage

If the engine will not be started for several weeks, the lubricating oil will drain from the cylinder walls and from the piston rings. Rust can form on the cylinder walls. Rust on the cylinder walls will cause increased engine wear and a reduction in engine service life.

Lubrication System

To help prevent excessive engine wear, use the following guidelines:

Complete all of the lubrication recommendations that are listed in this Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).

If an engine is out of operation and if use of the engine is not planned, special precautions should be made. If the engine will be stored for more than one month, a complete protection procedure is recommended.

Use the following guidelines :

- Completely clean the outside of the engine.
- Drain the fuel system completely and refill the system with preservative fuel. 1772204 POWERPART Lay-Up 1 can be mixed with the normal fuel in order to change the fuel into preservative fuel.
- If preservative fuel is not available, the fuel system can be filled with normal fuel. This fuel must be discarded at the end of the storage period together with the fuel filter elements.
- Operate the engine until the engine reaches normal operating temperature. Stop any leaks from fuel, lubricating oil or air systems. Stop the engine and drain the lubricating oil from the oil pan.
- Renew the canister(s) of the lubricating oil filter.
- Fill the oil pan to the Full Mark on the dipstick with new, clean lubricating oil. Add 1762811 POWERPART Lay-Up 2 to the oil in order to protect the engine against corrosion. If 1762811 POWERPART Lay-Up 2 is not available, use a preservative of the correct specification instead of the lubricating oil. If a preservative is used, this must be drained completely at the end of the storage period and the oil pan must be refilled to the correct level with normal lubricating oil.

Cooling System

To help prevent excessive engine wear, use the following guidelines:

NOTICE

Do not drain the coolant while the engine is still hot and the system is under pressure because dangerous hot coolant can be discharged.

If freezing temperatures are expected, check the cooling system for adequate protection against freezing. See this Operation and Maintenance Manual, "General Coolant Information" (Maintenance Section).

NOTICE

To prevent frost damage, ensure that all the coolant is removed from the engine. This is important if the system is drained after it has been flushed with water, or if an antifreeze solution too weak to protect the system from frost has been used.

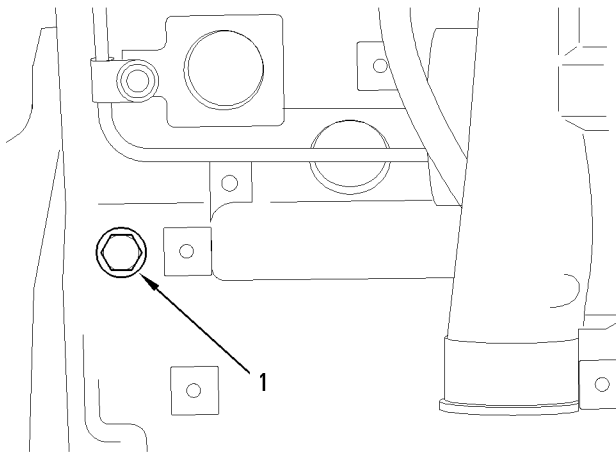


Illustration 15

g00989520

1. Ensure that the vehicle is on level ground.
2. Remove the filler cap of the cooling system.
3. Remove the drain plug (1) from the side of the cylinder block in order to drain the engine. Ensure that the drain hole is not restricted.
4. Open the tap or remove the drain plug at the bottom of the radiator in order to drain the radiator. If the radiator does not have a tap or a drain plug, disconnect the hose at the bottom of the radiator.
5. Flush the cooling system with clean water.

6. Fit the drain plugs and the filler cap. Close the tap or connect the radiator hose.
7. Fill the cooling system with an approved antifreeze mixture because this gives protection against corrosion.

Note: Certain corrosion inhibitors could cause damage to some engine components. Contact the Service Department of Perkins for advice.

8. Operate the engine for a short period in order to circulate the lubricating oil and the coolant in the engine.
9. Disconnect the battery. Put the battery into safe storage in a fully charged condition. Before the battery is put into storage, protect the terminals against corrosion. 1734115 POWERPART Lay-Up 3 can be used on the terminals.
10. Clean the crankcase breather if one is installed. Seal the end of the pipe.
11. Remove the fuel injector nozzles and spray 1762811 POWERPART Lay-Up 2 for one or two seconds into each cylinder bore with the piston at BDC.
12. Slowly rotate the crankshaft for one complete revolution and then replace the fuel injector nozzles.

Induction System

- Remove the air filter assembly. If necessary, remove the pipes that are installed between the air filter assembly and the turbocharger. Spray 1762811 POWERPART Lay-Up 2 into the turbocharger. The duration of the spray is printed on the container. Seal the turbocharger with waterproof tape.

Exhaust System

- Remove the exhaust pipe. Spray 1762811 POWERPART Lay-Up 2 into the turbocharger. The duration of the spray is printed on the container. Seal the turbocharger with waterproof tape.

General Items

- If the lubricating oil filler is installed on the rocker cover, remove the filler cap. If the lubricating oil filler cap is not installed on the rocker cover, remove the rocker cover. Spray 1762811 POWERPART Lay-Up 2 around the rocker shaft assembly. Replace the filler cap or the rocker cover.

- Seal the vent of the fuel tank or the fuel filler cap with waterproof tape.
- Remove the alternator drive belts and put the drive belts into storage.
- In order to prevent corrosion, spray the engine with 1734115 POWERPART Lay-Up 3. Do not spray the area inside the alternator.

When the engine protection has been completed in accordance with these instructions, this ensures that no corrosion will occur. Perkins are not responsible for damage which may occur when an engine is in storage after a period in service.

Your Perkins dealer or your Perkins distributor can assist in preparing the engine for extended storage periods.

Gauges and Indicators

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Gauges and Indicators

Your engine may not have the same gauges or all of the gauges that are described. For more information about the gauge package, see the OEM information.

Gauges provide indications of engine performance. Ensure that the gauges are in good working order. Determine the normal operating range by observing the gauges over a period of time.

Noticeable changes in gauge readings indicate potential gauge or engine problems. Problems may also be indicated by gauge readings that change even if the readings are within specifications. Determine and correct the cause of any significant change in the readings. Consult your Perkins dealer or your Perkins distributor for assistance.

Some engine applications are equipped with Indicator Lamps. Indicator lamps can be used as a diagnostic aid. There are two lamps. One lamp has an orange lens and the other lamp has a red lens.

These indicator lamps can be used in two ways:

- The indicator lamps can be used to identify the current operational status of the engine. The indicator lamps can also indicate that the engine has a fault. This system is automatically operated via the ignition switch.
- The indicator lamps can be used to identify active diagnostic codes. This system is activated by pressing the Flash Code button.

Refer to the Troubleshooting Guide, "Indicator Lamps" for further information.

NOTICE

If no oil pressure is indicated, STOP the engine. If maximum coolant temperature is exceeded, STOP the engine. Engine damage can result.



Engine Oil Pressure – The oil pressure should be greatest after a cold engine is started. The typical engine oil pressure with SAE10W30 is 207 to 413 kPa (30 to 60 psi) at rated rpm.

A lower oil pressure is normal at low idle. If the load is stable and the gauge reading changes, perform the following procedure:

1. Remove the load.
2. Reduce engine speed to low idle.
3. Check and maintain the oil level.



Jacket Water Coolant Temperature – Typical temperature range is 71 to 96°C (160 to 205°F). The maximum allowable temperature with the pressurized cooling system at 48 kPa (7 psi) is 110°C (230°F). Higher temperatures may occur under certain conditions. The water temperature reading may vary according to load. The reading should never exceed the boiling point for the pressurized system that is being used.

If the engine is operating above the normal range and steam becomes apparent, perform the following procedure:

1. Reduce the load and the engine rpm.
2. Inspect the cooling system for leaks.
3. Determine if the engine must be shut down immediately or if the engine can be cooled by reducing the load.



Tachometer – This gauge indicates engine speed (rpm). When the throttle control lever is moved to the full throttle position without load, the engine is running at high idle. The engine is running at the full load rpm when the throttle control lever is at the full throttle position with maximum rated load.

NOTICE

To help prevent engine damage, never exceed the high idle rpm. Overspeeding can result in serious damage to the engine. The engine can be operated at high idle without damage, but should never be allowed to exceed high idle rpm.



Ammeter – This gauge indicates the amount of charge or discharge in the battery charging circuit. Operation of the indicator should be to the right side of "0"(zero).



Fuel Level – This gauge indicates the fuel level in the fuel tank. The fuel level gauge operates when the "START/STOP" switch is in the "on" position.



Service Hour Meter – The gauge indicates operating time of the engine.

Features and Controls

i01902504

Monitoring System

WARNING

If the Shutdown mode has been selected and the warning indicator activates, engine shutdown may take as little as 20 seconds from the time the warning indicator is activated. Depending on the application, special precautions should be taken to avoid personal injury. The engine can be restarted following shutdown for emergency maneuvers, if necessary.

NOTICE

The Engine Monitoring System is not a guarantee against catastrophic failures. Programmed delays and derate schedules are designed to minimize false alarms and provide time for the operator to stop the engine.

The following parameters are monitored:

- Coolant temperature
- Intake manifold air temperature
- Intake manifold air pressure
- Oil pressure
- Fuel temperature
- Engine speed/timing

Programmable Options and Systems Operation

WARNING

If the Warning/Derate/Shutdown mode has been selected and the warning indicator activates, bring the engine to a stop whenever possible. Depending on the application, special precautions should be taken to avoid personal injury.

The engine can be programmed to the following modes:

“Warning”

The “Warning” lamp and the warning signal (orange lamp) turn “ON” and the warning signal is activated continuously in order to alert the operator that one or more of the engine parameters is not within normal operating range.

“Warning/Derate”

The “Diagnostic” lamp turns “ON” and the warning signal (red lamp) is activated. After the warning, the engine power will be derated. The warning lamp will begin to flash when the derating occurs.

The engine will be derated if the engine exceeds preset operational limits. The engine derate is achieved by restricting the amount of fuel that is available for each injection. The amount of this reduction of fuel is dependent on the severity of the fault that has caused the engine derate, typically up to a limit of 50%. This reduction in fuel results in a predetermined reduction in engine power.

“Warning/Derate/Shutdown”

The “Diagnostic” lamp turns “ON” and the warning signal (red lamp) is activated. After the warning, the engine power will be derated. The engine will continue at the rpm of the set derate until a shutdown of the engine occurs. The engine can be restarted after a shutdown for use in an emergency.

A shutdown of the engine may occur in as little as 20 seconds. The engine can be restarted after a shutdown for use in an emergency. However, the cause of the initial shutdown may still exist. The engine may shut down again in as little as 20 seconds.

If there is a signal for low oil pressure or for coolant temperature, there will be a two second delay in order to verify the condition.

For each of the programmed modes, refer to Troubleshooting Guide, “Indicator Lamps” for more information on Indicator Lamps.

For more information or assistance for repairs, consult your Perkins dealer or your Perkins distributor.

i01902952

Sensors and Electrical Components

Sensor Locations for the 1106 Engine

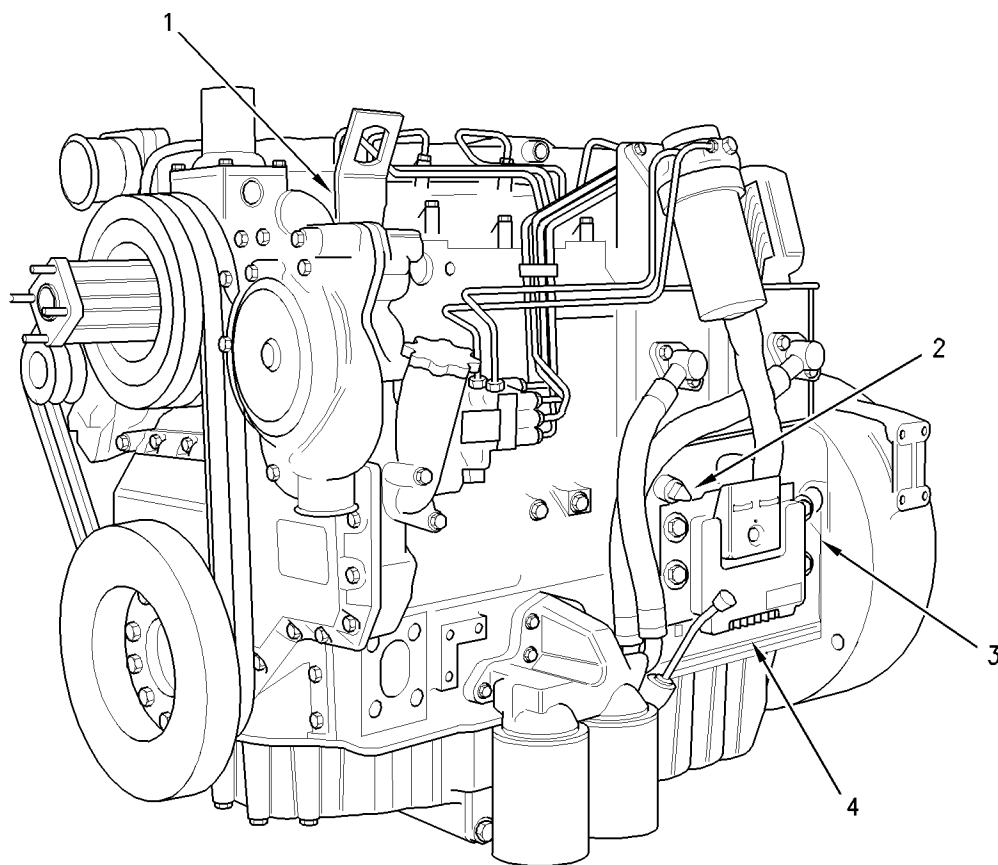


Illustration 16

g00894214

Left side view of the 1106 engine

Typical example of a 1106 engine

(1) Engine coolant temperature sensor
(2) Engine oil pressure sensor

(3) Speed/timing sensor
(4) Electronic control module (ECM)

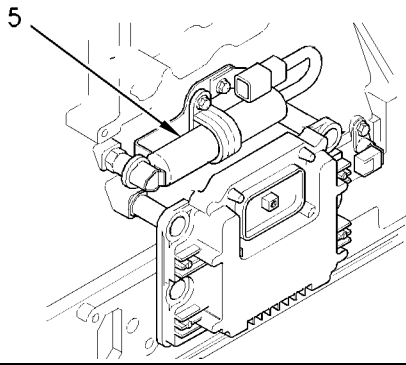


Illustration 17

g00912351

(5) Typical location of the voltage load protection module behind the ECM

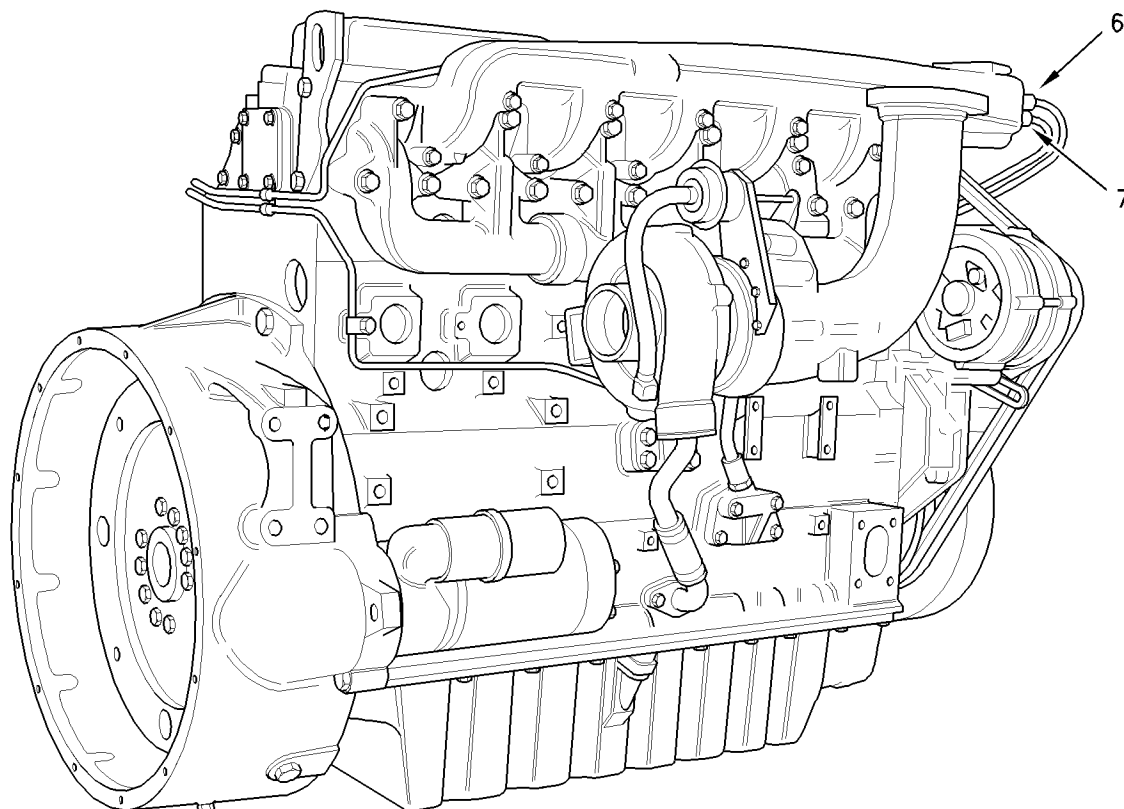


Illustration 18
Right side view of the 1106 engine
(6) Boost pressure sensor

(7) Inlet manifold temperature sensor

g00912359

Failure of Sensors

All Sensors

A failure of any of the sensors may be caused by one of the following malfunctions:

- Sensor output is open.
- Sensor output is shorted to “- battery” or “+ battery”.
- Measured reading of the sensor is out of the specification.

Boost Pressure Sensor

The boost pressure sensor provides a signal which corresponds to boost pressure to the ECM. The ECM can control injection timing and the amount of fuel that is injected. When the throttle is increased and when the engine demands more fuel, the fuel limit is controlled in order to reduce overall smoke levels of the engine exhaust.

Engine Oil Pressure Sensor

The engine oil pressure sensor is an absolute pressure sensor that measures the engine oil pressure in the main oil gallery. The engine oil pressure sensor detects engine oil pressure for diagnostic purposes. The engine oil pressure sensor sends a signal to the ECM.

Inlet Air Temperature Sensor

The inlet air temperature sensor measures the inlet air temperature. A signal is sent to the Electronic Control Module (ECM). The inlet air temperature sensor is also used by the ECM to determine initiation of the Cold Start Strategy and control for appropriate start of injection timing while the engine is warming up.

Coolant Temperature Sensor

The coolant temperature sensor monitors the engine coolant temperature. The output of the ECM can indicate a high coolant temperature through a relay or a lamp. The coolant temperature sensor is used by the ECM to determine initiation of the Cold Start Condition and control for appropriate start of injection timing while the engine is warming up.

Speed/Timing Sensor

If the ECM does not receive a signal from the primary speed/timing sensor the "DIAGNOSTIC" lamp will indicate a diagnostic fault code which will be logged in the ECM memory.

If the ECM does not receive a signal from the primary speed/timing sensor, the ECM will read the signal from the secondary speed/timing sensor. The ECM continually checks in order to determine if there is a signal from both sensors. If either sensor fails, the faulty sensor should be replaced.

Intermittent failure of the sensors will cause erratic engine control.

Throttle Position Sensor

The throttle position sensor (TPS) eliminates the mechanical throttle and governor linkages. The TPS interprets the position of the throttle lever into an electrical signal that is sent to the ECM. The throttle position signal and the engine speed/timing signal are processed by the ECM in order to precisely control engine speed.

Overspeed

An overspeed condition is detected by the Electronic Control Module (ECM). The event code E0190 will be logged if the engine speed exceeds 3300 rpm for the 1106. The "DIAGNOSTIC" lamp will indicate a diagnostic active code. The diagnostic active code will remain active until the engine speed drops to 3100 rpm.

Engine Diagnostics

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Self-Diagnostics

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Perkins Electronic Engines have the capability to perform a self-diagnostics test. When the system detects an active problem, a diagnostic lamp is activated. Diagnostic codes will be stored in permanent memory in the Electronic Control Module (ECM). The diagnostic codes can be retrieved by using the electronic service tool. Refer to Troubleshooting Guide, "Electronic Service Tools" for further information.

Some installations have electronic displays that provide direct readouts of the engine diagnostic codes. Refer to the manual that is provided by the OEM for more information on retrieving engine diagnostic codes. Alternatively refer to the Troubleshooting Guide, "Indicator Lamps" for further information.

Active codes represent problems that currently exist. These problems should be investigated first.

Logged codes represent the following items:

- Intermittent problems
- Recorded events
- Performance history

The problems may have been repaired since the logging of the code. These codes do not indicate that a repair is needed. The codes are guides or signals when a situation exists. Codes may be helpful to troubleshoot problems.

When the problems have been corrected, the corresponding logged fault codes should be cleared.

i01902948

Diagnostic Lamp

A diagnostic lamp is used to indicate the existence of an active fault. Refer to the Troubleshooting Guide, "Indicator Lamps" for more information. A fault diagnostic code will remain active until the problem is repaired. The diagnostic code may be retrieved by using the electronic service tool. Refer to the Troubleshooting Guide, "Electronic Service Tools" for more information.

Fault Logging

The system provides the capability of Fault Logging. When the Electronic Control Module (ECM) generates an active diagnostic code, the code will be logged in the memory of the ECM. The codes that have been logged by the ECM can be identified by the electronic service tool. The active codes that have been logged will be cleared when the fault has been rectified or the fault is no longer active. The following logged faults can not be cleared from the memory of the ECM without using a factory password: Overspeed, low engine oil pressure, and high engine coolant temperature.

i01902951

Engine Operation with Active Diagnostic Codes

If a diagnostic lamp illuminates during normal engine operation, the system has identified a situation that is not within the specification. Use the electronic service tool to check the active diagnostic codes.

The active diagnostic code should be investigated. The cause of the problem should be corrected as soon as possible. If the cause of the active diagnostic code is repaired and there is only one active diagnostic code, the diagnostic lamp will turn off.

Operation of the engine and performance of the engine can be limited as a result of the active diagnostic code that is generated. Acceleration rates may be significantly slower and power outputs may be automatically reduced. Refer to the Troubleshooting Guide, "Troubleshooting with a Diagnostic Code" for more information on the relationship between each active diagnostic code and the possible effect on engine performance.

i01902995

Engine Operation with Intermittent Diagnostic Codes

If a diagnostic lamp illuminates during normal engine operation and the diagnostic lamp shuts off, an intermittent fault may have occurred. If a fault has occurred, the fault will be logged into the memory of the Electronic Control Module (ECM).

In most cases, it is not necessary to stop the engine because of an intermittent code. However, the operator should retrieve the logged fault codes and the operator should reference the appropriate information in order to identify the nature of the event. The operator should log any observation that could have caused the lamp to light.

- Low power
- Limits of the engine speed
- Excessive smoke, etc

This information can be useful to help troubleshoot the situation. The information can also be used for future reference. For more information on diagnostic codes, refer to the Troubleshooting Guide for this engine.

Engine Starting

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Before Starting Engine

Before the engine is started, perform the required daily maintenance and any other periodic maintenance that is due. Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for more information.

- For the maximum service life of the engine, make a thorough inspection within the engine compartment before the engine is started. Look for the following items: oil leaks, coolant leaks, loose bolts, and excessive dirt and/or grease. Remove any excess dirt and/or grease buildup. Repair any faults that were identified during the inspection.
- Inspect the cooling system hoses for cracks and for loose clamps.
- Inspect the alternator and accessory drive belts for cracks, breaks, and other damage.
- Inspect the wiring for loose connections and for worn wires or frayed wires.
- Check the fuel supply. Drain water from the water separator (if equipped). Open the fuel supply valve (if equipped).

NOTICE

All valves in the fuel return line must be open before and during engine operation to help prevent high fuel pressure. High fuel pressure may cause filter housing failure or other damage.

If the engine has not been started for several weeks, fuel may have drained from the fuel system. Air may have entered the filter housing. Also, when fuel filters have been changed, some air pockets will be trapped in the engine. In these instances, prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" for more information on priming the fuel system.

WARNING

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

- Do not start the engine or move any of the controls if there is a "DO NOT OPERATE" warning tag or similar warning tag attached to the start switch or to the controls.
- Ensure that the areas around the rotating parts are clear.
- All of the guards must be put in place. Check for damaged guards or for missing guards. Repair any damaged guards. Replace damaged guards and/or missing guards.
- Disconnect any battery chargers that are not protected against the high current drain that is created when the electric starting motor is engaged. Check electrical cables and check the battery for poor connections and for corrosion.
- Reset all of the shutoffs or alarm components (if equipped).
- Check the engine lubrication oil level. Maintain the oil level between the "ADD" mark and the "FULL" mark on the oil level dipstick.
- Check the coolant level. Observe the coolant level in the header tank (if equipped). Maintain the coolant level to the "FULL" mark on the header tank.
- If the engine is not equipped with a header tank maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level in the sight glass.
- Observe the air cleaner service indicator (if equipped). Service the air cleaner when the yellow diaphragm enters the red zone, or when the red piston locks in the visible position.
- Ensure that any equipment that is driven by the engine has been disengaged from the engine. Minimize electrical loads or remove any electrical loads.

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Starting the Engine

Note: Do not adjust the engine speed control during start-up. The electronic control module (ECM) will control the engine speed during start-up.

Starting a Cold Engine

1. Disengage any equipment that is driven by the engine.

2. Turn the keyswitch to the RUN position. Leave the keyswitch in the RUN position for 15 seconds.
3. Turn the keyswitch to the START position in order to engage the electric starting motor and crank the engine.

NOTICE

Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again.

4. Allow the keyswitch to return to the RUN position after the engine starts.
5. Repeat step 2 through step 4 if the engine fails to start.

Starting a Warm Engine

1. Disengage any equipment that is driven by the engine.
2. Turn the keyswitch to the START position in order to engage the electric starting motor and crank the engine.

NOTICE

Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again.

3. Allow the keyswitch to return to the RUN position after the engine starts.
4. Repeat step 2 and step 3 if the engine fails to start.

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Cold Weather Starting

**WARNING**

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

Startability will be improved at temperatures below -18°C (0°F) from the use of a jacket water heater or extra battery capacity.

When Group 2 diesel fuel is used, the following items provide a means of minimizing starting problems and fuel problems in cold weather: Engine oil pan heaters, jacket water heaters, fuel heaters, and fuel line insulation.

Use the procedure that follows for cold weather starting.

Note: Do not adjust the engine speed control during start-up. The electronic control module (ECM) will control the engine speed during start-up.

1. Disengage any driven equipment.
2. Turn the keyswitch to the RUN position. Leave the keyswitch in the RUN position for 15 seconds.

NOTICE

Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again.

3. Turn the keyswitch to the START position in order to engage the starting motor and crank the engine.
4. Allow the keyswitch to return to the RUN position after the engine starts.
5. Repeat step 2 through step 4 if the engine fails to start.

Note: The engine should not be “raced” in order to speed up the warm up process.

6. Allow the engine to idle for three to five minutes, or allow the engine to idle until the water temperature indicator begins to rise. When idling after the engine has started in cold weather, increase the engine rpm from 1000 to 1200 rpm. This will warm up the engine more quickly. Maintaining an elevated low idle speed for extended periods will be easier with the installation of a hand throttle. Allow the white smoke to disperse before proceeding with normal operation.

7. Operate the engine at low load until all systems reach operating temperature. Check the gauges during the warm-up period.

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Starting with Jump Start Cables

WARNING

Improper jump start cable connections can cause an explosion resulting in personal injury.

Prevent sparks near the batteries. Sparks could cause vapors to explode. Do not allow jump start cable ends to contact each other or the engine.

Note: If it is possible, first diagnose the reason for the starting failure. Refer to Troubleshooting, “Engine Will Not Crank and Engine Cranks But Will Not Start” for further information. Make any necessary repairs. If the engine will not start only due to the condition of the battery, either charge the battery, or start the engine with jump start cables. The condition of the battery can be rechecked after the engine has been switched OFF.

NOTICE

Using a battery source with the same voltage as the electric starting motor. Use **ONLY** equal voltage for jump starting. The use of higher voltage will damage the electrical system.

Do not reverse the battery cables. The alternator can be damaged. Attach ground cable last and remove first.

When using an external electrical source to start the engine, turn the generator set control switch to the “OFF” position. Turn all electrical accessories OFF before attaching the jump start cables.

Ensure that the main power switch is in the OFF position before attaching the jump start cables to the engine being started.

1. Turn the start switch on the stalled engine to the OFF position. Turn off all the engine’s accessories.
2. Connect one positive end of the jump start cable to the positive cable terminal of the discharged battery. Connect the other positive end of the jump start cable to the positive cable terminal of the electrical source.

3. Connect one negative end of the jump start cable to the negative cable terminal of the electrical source. Connect the other negative end of the jump start cable to the engine block or to the chassis ground. This procedure helps to prevent potential sparks from igniting the combustible gases that are produced by some batteries.
4. Start the engine.
5. Immediately after the stalled engine is started, disconnect the jump start cables in reverse order.

After jump starting, the alternator may not be able to fully recharge batteries that are severely discharged. The batteries must be replaced or charged to the proper voltage with a battery charger after the engine is stopped. Many batteries which are considered unusable are still rechargeable. Refer to Operation and Maintenance Manual, “Battery - Replace” and Testing and Adjusting Manual, “Battery - Test”.

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After Starting Engine

Note: In temperatures from 0 to 60°C (32 to 140°F), the warm-up time is approximately three minutes. In temperatures below 0°C (32°F), additional warm-up time may be required.

When the engine idles during warm-up, observe the following conditions:

- Check for any fluid or for any air leaks at idle rpm and at one-half full rpm (no load on the engine) before operating the engine under load. This is not possible in some applications.
- Operate the engine at low idle until all systems achieve operating temperatures. Check all gauges during the warm-up period.

Note: Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

Engine Operation

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Engine Operation

Proper operation and maintenance are key factors in obtaining the maximum life and economy of the engine. If the directions in the Operation and Maintenance Manual are followed, costs can be minimized and engine service life can be maximized.

The engine can be operated at the rated rpm after the engine reaches operating temperature. The engine will reach normal operating temperature sooner during a low engine speed (rpm) and during a low power demand. This procedure is more effective than idling the engine at no load. The engine should reach operating temperature in a few minutes.

Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

Engine Stopping

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Stopping the Engine

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NOTICE

Stopping the engine immediately after it has been working under load can result in overheating and accelerated wear of the engine components.

If the engine has been operating at high rpm and/or high loads, run at low idle for at least three minutes to reduce and stabilize internal engine temperature before stopping the engine.

Avoiding hot engine shutdowns will maximize turbocharger shaft and bearing life.

Prior to stopping an engine that is being operated at low loads, operate the engine at low idle for 30 seconds before stopping. If the engine has been operating at highway speeds and/or at high loads, operate the engine at low idle for at least three minutes. This procedure will cause the internal engine temperature to be reduced and stabilized.

Ensure that the engine stopping procedure is understood. Stop the engine according to the shutoff system on the engine or refer to the instructions that are provided by the OEM.

- To stop the engine, turn the ignition key switch to the OFF position.

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Emergency Stopping

NOTICE

Emergency shutoff controls are for EMERGENCY use ONLY. DO NOT use emergency shutoff devices or controls for normal stopping procedure.

The OEM may have equipped the application with an emergency stop button. For more information about the emergency stop button, refer to the OEM information.

Ensure that any components for the external system that support the engine operation are secured after the engine is stopped.

After Stopping Engine

Note: Before you check the engine oil, do not operate the engine for at least 10 minutes in order to allow the engine oil to return to the oil pan.

- Check the crankcase oil level. Maintain the oil level between the “ADD” mark and the “FULL” mark on the oil level dipstick.
 - If necessary, perform minor adjustments. Repair any leaks and tighten any loose bolts.
 - Note the required service interval. Perform the maintenance that is in the Operation and Maintenance Manual, “Maintenance Interval Schedule”.
 - Fill the fuel tank in order to help prevent accumulation of moisture in the fuel. Do not overfill the fuel tank.
-

NOTICE

Only use antifreeze/coolant mixtures recommended in the Coolant Specifications that are in the Operation and Maintenance Manual. Failure to do so can cause engine damage.

- Allow the engine to cool. Check the coolant level.
- If freezing temperatures are expected, check the coolant for the correct antifreeze protection. The cooling system must be protected against freezing to the lowest expected outside temperature. Add the correct coolant/water mixture, if necessary.
- Perform all required periodic maintenance on all driven equipment. This maintenance is outlined in the instructions from the OEM.

Cold Weather Operation

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Cold Weather Operation

Perkins Diesel Engines can operate effectively in cold weather. During cold weather, the starting and the operation of the diesel engine is dependent on the following items:

- The type of fuel that is used
- The viscosity of the oil
- The operation of the air inlet heater starting aid
- Optional Cold starting aid

The purpose of this section will cover the following information:

- Explain potential problems that are caused by cold weather operation.
- Suggest steps which can be taken in order to minimize starting problems and operating problems when the ambient air temperature is colder than 0 to -55 °C (32 to -67 °F).

The operation and maintenance of an engine in freezing temperatures is complex. This is because of the following conditions: the unlimited differences in weather conditions, engine applications, and the supplies that are available in your area. These factors and recommendations from your Perkins dealer are based on past proven practices. The information that is contained in this section should be combined in order to provide guidelines for cold weather operations.

Hints for Cold Weather Operation

- If the engine will start, operate the engine until a minimum operating temperature of 71 °C (160 °F) is achieved. Achieving operating temperature will help prevent the intake valves and exhaust valves from sticking.
- The cooling system and the lubrication system for the engine do not lose heat immediately upon shutdown. This means that an engine can be shut down for a few hours and the engine can still have the ability to start readily. If the engine is shut down for at least eight hours, the engine should be considered cooled to outside temperature.

- Install the correct lubricant in each compartment before the beginning of cold weather.
- Check all rubber parts (hoses, fan drive belts, etc) weekly.
- Check all electrical wiring and connections for any fraying or damaged insulation.
- Keep all batteries fully charged and warm.
- Fill the fuel tank at the end of each shift.
- Check the air cleaners and the air intake daily. Check the air intake more often when you operate in snow.

WARNING

Personal injury or property damage can result from alcohol or starting fluids.

Alcohol or starting fluids are highly flammable and toxic and if improperly stored could result in injury or property damage.

WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

- For jump starting with cables in cold weather, refer to the Operation and Maintenance Manual, "Starting with Jump Start Cables." for instructions.

Viscosity of the Engine Lubrication Oil

Proper engine oil viscosity is essential. Oil viscosity affects the amount of torque that is needed to crank the engine. Refer to the Operation and Maintenance Manual, "Lubricant Specifications" for the recommended viscosity of oil.

Recommendations for the Coolant

Provide cooling system protection for the lowest expected outside temperature. Refer to the Operation and Maintenance Manual, "General Coolant Information" for the recommended coolant mixture.

In cold weather, check the coolant often for the proper glycol concentration in order to ensure adequate freeze protection.

Engine Block Heaters

Engine block heaters (if equipped) heat the engine jacket water that surrounds the combustion chambers. This provides the following functions:

- Startability is improved.
- Warm up time is reduced.

An electric block heater can be activated once the engine is stopped. An effective block heater is typically a 1250/1500 W unit. Consult your Perkins dealer or your Perkins distributor for more information.

Idling the Engine

When idling after the engine is started in cold weather, increase the engine rpm from 1000 to 1200 rpm. This will warm up the engine more quickly. Maintaining an elevated low idle speed for extended periods will be easier with the installation of a hand throttle. The engine should not be “raced” in order to speed up the warm up process.

While the engine is idling, the application of a light load (parasitic load) will assist in maintaining the minimum operating temperature. The minimum operating temperature is 71 °C (160 °F).

Recommendations for Coolant Warm Up

Warm up an engine that has cooled below normal operating temperatures due to inactivity. This should be performed before the engine is returned to full operation. During operation in very cold temperature conditions, damage to engine valve mechanisms can result from engine operation for short intervals. This can happen if the engine is started and the engine is stopped many times without being operated in order to warm up completely.

When the engine is operated below normal operating temperatures, fuel and oil are not completely burned in the combustion chamber. This fuel and oil causes soft carbon deposits to form on the valve stems. Generally, the deposits do not cause problems and the deposits are burned off during operation at normal engine operating temperatures.

When the engine is started and the engine is stopped many times without being operated in order to warm up completely, the carbon deposits become thicker. This will cause the following problems:

- Free operation of the valves is prevented.
- Valves become stuck.

- Pushrods are bent.
- Other damage to valve train components can result.

For this reason, when the engine is started, the engine must be operated until the coolant temperature is 71 °C (160 °F) minimum. Carbon deposits on the valve stems will be kept at a minimum and the free operation of the valves and the valve components will be maintained.

In addition, the engine must be thoroughly warmed in order to keep other engine parts in better condition and the service life of the engine will be generally extended. Lubrication will be improved. There will be less acid and less sludge in the oil. This will provide longer service life for the engine bearings, the piston rings, and other parts. However, limit unnecessary idle time to ten minutes in order to reduce wear and unnecessary fuel consumption.

Purge Valve and Insulated Heater Lines

The engine is equipped with a water temperature regulator in order to allow the engine to reach the correct operating temperature quickly. The water temperature regulator remains in the closed position until the jacket water coolant temperature has reached the engine's operating temperature. The jacket water circulates from the top of the cylinder block, to the water temperature regulator housing, and back to the bottom of the cylinder block via the bypass. The water temperature regulator allows some flow of water and/or air to pass through the water temperature regulator in order to ensure a continuous flow of coolant within the cylinder block. This is achieved via a small “jiggle” valve in the water temperature regulator. The water temperature regulator moves to the open position when the jacket water coolant temperature has reached the correct operating temperature. The water temperature regulator moves to the open position in order to allow the passage of the coolant through the radiator to dissipate excess heat.

The above procedure is good for normal engine operating conditions in temperate climates. During periods of operations in a cold climate with a light engine load, the coolant must bypass the radiator in order to help prevent excessive cooling of the engine. Coolant that passes through the radiator must be minimized in order to maintain the engine operating temperature in cold weather.

Excessive cooling of the engine can be prevented by a valve that allows unnecessary coolant flow to be diverted from the water temperature regulator and back to the bottom of the engine block without passing through the radiator.

Note: Perkins discourages the use of all airflow restriction devices such as radiator shutters. Restriction of the airflow can result in the following: high exhaust temperatures, power loss, excessive fan usage, and reduction in fuel economy.

Cab heater lines for very cold weather are also beneficial. These lines provide more available heat from the coolant to the cab. The feed from the engine and the return lines from the cab should be insulated in order to reduce heat loss to the outside air.

Insulating the Air Inlet and Engine Compartment

When temperatures below -18°C (-0°F) will be frequently encountered, an air cleaner inlet that is located in the engine compartment may be specified. An air cleaner that is located in the engine compartment may also minimize the entry of snow into the air cleaner. Also, heat that is rejected by the engine helps to warm the intake air.

Additional heat can be retained around the engine by insulating the engine compartment.

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Fuel and the Effect from Cold Weather

Note: Only use grades of fuel that are recommended by Perkins. Refer to this Operation and Maintenance Manual, "Fuel Recommendations".

The following fuels can be used for the Perkins 1106 engine.

- Group 1
- Group 2
- Group 3
- Special Fuels

Perkins prefer only Group 1 and Group 2 fuels for use in 1106 engines. Group 3 fuels include Low Temperature Fuels and Aviation Kerosene Fuels.

Note: Group 3 fuels reduce the life of the engine. The use of Group 3 fuels is not covered by the Perkins warranty.

Special fuels include Biofuel.

Group 1 fuels are the preferred Group of Fuels for general use by Perkins. Group 1 fuels maximize engine life and engine performance. Group 1 fuels are usually less available than Group 2 fuels. Frequently, Group 1 fuels are not available in colder climates during the winter.

Note: Group 2 fuels must have a maximum wear scar of 650 micrometers (HFRR to ISO 12156-1). Group 2 fuels can only be used on VP30 fuel injection pumps that operate on a 24 volt system.

Group 2 fuels are considered acceptable for issues of warranty. This group of fuels may reduce the life of the engine, the engine's maximum power, and the engine's fuel efficiency.

When Group 2 diesel fuels are used the following components provide a means of minimizing problems in cold weather:

- An air inlet heater starting aid, which is standard equipment on all 1106 engines
- Engine coolant heaters, which may be an OEM option
- Fuel heaters, which may be an OEM option
- Fuel line insulation, which may be an OEM option

There are three major differences between Group 1 fuels and Group 2 fuels. Group 1 fuels have the following different characteristics to Group 2 fuels.

- A lower cloud point
- A lower pour point
- A higher rating of kJ (BTU) per unit volume of fuel

The cloud point is the temperature when a cloud of wax crystals begins to form in the fuel. These crystals can cause the fuel filters to plug. The pour point is the temperature when diesel fuel will thicken. The diesel fuel becomes more resistant to flow through fuel pumps and through the fuel lines.

Be aware of these values when diesel fuel is purchased. Consider the average ambient air temperature for the engine's application. Engines that are fueled in one climate may not operate well if the engines are moved to another climate. Problems can result due to changes in temperature.

Before troubleshooting for low power or for poor performance in the winter, check the type of fuel that is being used.

Low temperature fuels may be available for engine operation at temperatures below 0 °C (32 °F). These fuels limit the formation of wax in the fuel at low temperatures. Wax in the fuel may prevent the flow of the fuel through the fuel filters.

For more information on cold weather operation, see Operation and Maintenance Manual, “Cold Weather Operation and Fuel Related Components in Cold Weather”.

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Fuel Related Components in Cold Weather

Fuel Tanks

Condensation can form in partially filled fuel tanks. Top off the fuel tanks after you operate the engine.

Fuel tanks should contain some provision for draining water and sediment from the bottom of the tanks. Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe.

Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Drain the water and sediment from any fuel storage tank at the following intervals: weekly, oil changes, and refueling of the fuel tank. This will help prevent water and/or sediment from being pumped from the fuel storage tank and into the engine fuel tank.

Fuel Filters

It is possible that a primary fuel filter is installed between the fuel tank and the engine fuel inlet. After you change the fuel filter, always prime the fuel system in order to remove air bubbles from the fuel system. Refer to the Operation and Maintenance Manual in the Maintenance Section for more information on priming the fuel system.

The micron rating and the location of a primary fuel filter is important in cold weather operation. The primary fuel filter and the fuel supply line are the most common components that are affected by cold fuel.

Fuel Heaters

Note: The OEM may equip the application with fuel heaters. If this is the case, disconnect an electric type of fuel heater in warm weather in order to prevent overheating of the fuel. If the type of fuel heater is a heat exchanger, the OEM should have included a bypass for warm weather. Ensure that the bypass is operational during warm weather in order to prevent overheating of the fuel.

For more information about fuel heaters (if equipped), refer to the OEM information.

Maintenance Section

Lubricant Specifications

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Lubricant Information

General Information

Because of government regulations regarding the certification of engine exhaust emissions, the lubricant recommendations must be followed.

Engine Manufacturers Association (EMA) Oils

The “Engine Manufacturers Association Recommended Guideline on Diesel Engine Oil” is recognized by Perkins. For detailed information about this guideline, see the latest edition of EMA publication, “EMA DHD -1”.

API Oils

The Engine Oil Licensing and Certification System by the American Petroleum Institute (API) is recognized by Perkins. For detailed information about this system, see the latest edition of the “API publication No. 1509”. Engine oils that bear the API symbol are authorized by API.

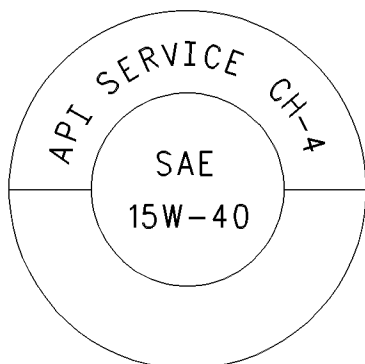


Illustration 19

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Typical API symbol

Diesel engine oils CC, CD, CD-2, and CE have not been API authorized classifications since 1 January 1996. Table 2 summarizes the status of the classifications.

Table 2

API Classifications	
Current	Obsolete
CF-4, CG-4, CH-4	CE
CF	CC, CD
CF-2 ⁽¹⁾	CD-2 ⁽¹⁾

⁽¹⁾ The classifications CD-2 and American Petroleum Institute CF-2 are for two-cycle diesel engines. Perkins does not sell engines that utilize CD-2 and API CF-2 oils.

Terminology

Certain abbreviations follow the nomenclature of “SAE J754”. Some classifications follow “SAE J183” abbreviations, and some classifications follow the “EMA Recommended Guideline on Diesel Engine Oil”. In addition to Perkins definitions, there are other definitions that will be of assistance in purchasing lubricants. Recommended oil viscosities can be found in this publication, “Engine Oil” topic (Maintenance Section).

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Engine Oil

Commercial Oils

The performance of commercial diesel engine oils is based on American Petroleum Institute (API) classifications. These API classifications are developed in order to provide commercial lubricants for a broad range of diesel engines that operate at various conditions.

Only use commercial oils that meet the following classifications:

- EMA DHD-1 multigrade oil (preferred oil)
- API CH-4 multigrade oil (preferred oil)
- ACEAE3

In order to make the proper choice of a commercial oil, refer to the following explanations:

EMA DHD-1 – The Engine Manufacturers Association (EMA) has developed lubricant recommendations as an alternative to the API oil classification system. DHD-1 is a Recommended Guideline that defines a level of oil performance for these types of diesel engines: high speed, four stroke cycle, heavy-duty, and light duty. DHD-1 oils may be used in Perkins engines when the following oils are recommended: API CH-4, API CG-4, and API CF-4. DHD-1 oils are intended to provide superior performance in comparison to API CG-4 and API CF-4.

DHD-1 oils will meet the needs of high performance Perkins diesel engines that are operating in many applications. The tests and the test limits that are used to define DHD-1 are similar to the new API CH-4 classification. Therefore, these oils will also meet the requirements of the low emissions diesel engines. DHD-1 oils are designed to control the harmful effects of soot with improved wear resistance and improved resistance to plugging of the oil filter. These oils will also provide superior piston deposit control for engines with either two-piece steel pistons or aluminum pistons.

All DHD-1 oils must complete a full test program with the base stock and with the viscosity grade of the finished commercial oil. The use of “API Base Oil Interchange Guidelines” are not appropriate for DHD-1 oils. This feature reduces the variation in performance that can occur when base stocks are changed in commercial oil formulations.

DHD-1 oils are recommended for use in extended oil change interval programs that optimize oil life. These oil change interval programs are based on oil analysis. DHD-1 oils are recommended for conditions that demand a premium oil. Your Perkins dealer or your Perkins distributor has the specific guidelines for optimizing oil change intervals.

API CH-4 – API CH-4 oils were developed in order to meet the requirements of the new high performance diesel engines. Also, the oil was designed to meet the requirements of the low emissions diesel engines. API CH-4 oils are also acceptable for use in older diesel engines and in diesel engines that use high sulfur diesel fuel. API CH-4 oils may be used in Perkins engines that use API CG-4 and API CF-4 oils. API CH-4 oils will generally exceed the performance of API CG-4 oils in the following criteria: deposits on pistons, control of oil consumption, wear of piston rings, valve train wear, viscosity control, and corrosion.

Three new engine tests were developed for the API CH-4 oil. The first test specifically evaluates deposits on pistons for engines with the two-piece steel piston. This test (piston deposit) also measures the control of oil consumption. A second test is conducted with moderate oil soot. The second test measures the following criteria: wear of piston rings, wear of cylinder liners, and resistance to corrosion. A third new test measures the following characteristics with high levels of soot in the oil: wear of the valve train, resistance of the oil in plugging the oil filter, and control of sludge.

In addition to the new tests, API CH-4 oils have tougher limits for viscosity control in applications that generate high soot. The oils also have improved oxidation resistance. API CH-4 oils must pass an additional test (piston deposit) for engines that use aluminum pistons (single piece). Oil performance is also established for engines that operate in areas with high sulfur diesel fuel.

All of these improvements allow the API CH-4 oil to achieve optimum oil change intervals. API CH-4 oils are recommended for use in extended oil change intervals. API CH-4 oils are recommended for conditions that demand a premium oil. Your Perkins dealer or your Perkins distributor has specific guidelines for optimizing oil change intervals.

Some commercial oils that meet the API classifications may require reduced oil change intervals. To determine the oil change interval, closely monitor the condition of the oil and perform a wear metal analysis.

NOTICE

Failure to follow these oil recommendations can cause shortened engine service life due to deposits and/or excessive wear.

Total Base Number (TBN) and Fuel Sulfur Levels for Direct Injection (DI) Diesel Engines

The Total Base Number (TBN) for an oil depends on the fuel sulfur level. For direct injection engines that use distillate fuel, the minimum TBN of the new oil must be 10 times the fuel sulfur level. The TBN is defined by “ASTM D2896”. The minimum TBN of the oil is 5 regardless of fuel sulfur level. Illustration 20 demonstrates the TBN.

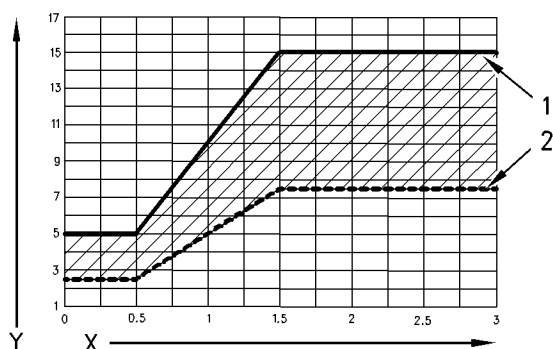


Illustration 20

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(Y) TBN by "ASTM D2896"

(X) Percentage of fuel sulfur by weight

(1) TBN of new oil

(2) Change the oil when the TBN deteriorates to 50 percent of the original TBN.

Use the following guidelines for fuel sulfur levels that exceed 1.5 percent:

- Choose an oil with the highest TBN that meets one of these classifications: EMA DHD-1 and API CH-4.
- Reduce the oil change interval. Base the oil change interval on the oil analysis. Ensure that the oil analysis includes the condition of the oil and a wear metal analysis.

Excessive piston deposits can be produced by an oil with a high TBN. These deposits can lead to a loss of control of the oil consumption and to the polishing of the cylinder bore.

NOTICE

Operating Direct Injection (DI) diesel engines with fuel sulphur levels over 0.5 percent will require shortened oil change intervals in order to help maintain adequate wear protection.

Table 3

Percentage of Sulfur in the fuel	Oil change interval
Lower than 0.5	Normal
0.5 to 1.0	0.75 of normal
Greater than 1.0	0.50 of normal

Lubricant Viscosity Recommendations for Direct Injection (DI) Diesel Engines

The proper SAE viscosity grade of oil is determined by the minimum ambient temperature during cold engine start-up, and the maximum ambient temperature during engine operation.

Refer to Table 4 (minimum temperature) in order to determine the required oil viscosity for starting a cold engine.

Refer to Table 4 (maximum temperature) in order to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

Generally, use the highest oil viscosity that is available to meet the requirement for the temperature at start-up.

Table 4

EMA LRG-1 API CH-4 Viscosity Grade	Engine Oil Viscosity	
	Ambient Temperature	
	Minimum	Maximum
SAE 0W20	-40 °C (-40 °F)	10 °C (50 °F)
SAE 0W30	-40 °C (-40 °F)	30 °C (86 °F)
SAE 0W40	-40 °C (-40 °F)	40 °C (104 °F)
SAE 5W30	-30 °C (-22 °F)	30 °C (86 °F)
SAE 5W40	-30 °C (-22 °F)	40 °C (104 °F)
SAE 10W30	-20 °C (-4 °F)	40 °C (104 °F)
SAE 15W40	-10 °C (14 °F)	50 °C (122 °F)

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Synthetic Base Stock Oils

Synthetic base oils are acceptable for use in these engines if these oils meet the performance requirements that are specified for the engine.

Synthetic base oils generally perform better than conventional oils in the following two areas:

- Synthetic base oils have improved flow at low temperatures especially in arctic conditions.
- Synthetic base oils have improved oxidation stability especially at high operating temperatures.

Some synthetic base oils have performance characteristics that enhance the service life of the oil. Perkins does not recommend the automatic extending of the oil change intervals for any type of oil.

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Re-refined Base Stock Oils

Re-refined base stock oils are acceptable for use in Perkins engines if these oils meet the performance requirements that are specified by Perkins. Re-refined base stock oils can be used exclusively in finished oil or in a combination with new base stock oils. The US military specifications and the specifications of other heavy equipment manufacturers also allow the use of re-refined base stock oils that meet the same criteria.

The process that is used to make re-refined base stock oil should adequately remove all wear metals that are in the used oil and all the additives that are in the used oil. The process that is used to make re-refined base stock oil generally involves the process of vacuum distillation and hydrotreating the used oil. Filtering is adequate for the production of high quality, re-refined base stock oil.

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Cold Weather Lubricants

When an engine is started and an engine is operated in ambient temperatures below -20°C (-4°F), use multigrade oils that are capable of flowing in low temperatures.

These oils have lubricant viscosity grades of SAE 0W or SAE 5W.

When an engine is started and operated in ambient temperatures below -30°C (-22°F), use a synthetic base stock multigrade oil with a 0W viscosity grade or with a 5W viscosity grade. Use an oil with a pour point that is lower than -50°C (-58°F).

The number of acceptable lubricants is limited in cold weather conditions. Perkins recommends the following lubricants for use in cold weather conditions:

First Choice – Use oil with an EMA DHD-1 Recommended Guideline. Use a CH-4 oil that has an API license. The oil should be either SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade.

Second Choice – Use an oil that has a CH-4 additive package. Although the oil has not been tested for the requirements of the API license, the oil must be either SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40.

NOTICE

Shortened engine service life could result if second choice oils are used.

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Aftermarket Oil Additives

Perkins does not recommend the use of aftermarket additives in oil. It is not necessary to use aftermarket additives in order to achieve the engine's maximum service life or rated performance. Fully formulated, finished oils consist of base oils and of commercial additive packages. These additive packages are blended into the base oils at precise percentages in order to help provide finished oils with performance characteristics that meet industry standards.

There are no industry standard tests that evaluate the performance or the compatibility of aftermarket additives in finished oil. Aftermarket additives may not be compatible with the finished oil's additive package, which could lower the performance of the finished oil. The aftermarket additive could fail to mix with the finished oil. This could produce sludge in the crankcase. Perkins discourages the use of aftermarket additives in finished oils.

To achieve the best performance from a Perkins engine, conform to the following guidelines:

- Select the proper oil, or a commercial oil that meets the "EMA Recommended Guideline on Diesel Engine Oil" or the recommended API classification.
- See the appropriate "Lubricant Viscosities" table in order to find the correct oil viscosity grade for your engine.
- At the specified interval, service the engine. Use new oil and install a new oil filter.
- Perform maintenance at the intervals that are specified in the Operation and Maintenance Manual, "Maintenance Interval Schedule".

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S·O·S Oil Analysis

Some engines may be equipped with an oil sampling valve. If S·O·S oil analysis is required the oil sampling valve is used to obtain samples of the engine oil. The S·O·S oil analysis will complement the preventive maintenance program.

The S·O·S oil analysis is a diagnostic tool that is used to determine oil performance and component wear rates. Contamination can be identified and measured through the use of the S·O·S oil analysis. The S·O·S oil analysis includes the following tests:

- The Wear Rate Analysis monitors the wear of the engine's metals. The amount of wear metal and type of wear metal that is in the oil is analyzed. The increase in the rate of engine wear metal in the oil is as important as the quantity of engine wear metal in the oil.
- Tests are conducted in order to detect contamination of the oil by water, glycol or fuel.
- The Oil Condition Analysis determines the loss of the oil's lubricating properties. An infrared analysis is used to compare the properties of new oil to the properties of the used oil sample. This analysis allows technicians to determine the amount of deterioration of the oil during use. This analysis also allows technicians to verify the performance of the oil according to the specification during the entire oil change interval.

Fuel Specifications

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Fuel Recommendations

To get the correct power and performance from the engine, use a fuel of the correct quality. The recommended fuel specification for the Perkins 1106 engine is shown below:

- Cetane number _____ 45 minimum
- Viscosity _____ 2,0 to 4.5 cSt at 40 °C (104 °F)
- Density _____ 0.835 to 0.855 Kg/liter
- Sulfur _____ 0.2% of mass, maximum
- Distillation _____ 85% at 350 °C (662 °F)
- Lubricity _____ 460 micrometers maximum wear scar on "ISO 12156 - 1"

Cetane number

This indicates the properties of ignition of the fuel. Fuel with a low cetane number can be the root cause of problems during cold start. This will affect combustion.

Viscosity

This is the resistance to flow of a fluid. If this resistance is outside the limits, the engine and the engine starting performance in particular can be affected.

Sulfur

High sulfur content of the fuel is not normally found in Europe, North America or Australasia. This can cause engine wear. When only high sulfur fuels are available, it will be necessary that high alkaline lubricating oil is used in the engine or that the lubricating oil change interval is reduced.

Distillation

This is an indication of the mixture of different hydrocarbons in the fuel. A high ratio of light weight hydrocarbons can affect the characteristics of combustion.

Lubricity

This is the capability of the fuel to prevent pump wear.

Diesel engines have the ability to burn a wide variety of fuels. These fuels are divided into four general groups:

- Group 1 (preferred fuels)
- Group 2 (permissible fuels)
- Group 3 (aviation kerosene fuels)
- Other fuels

Group 1 (preferred fuels): Specification

"DERV to EN590"

Note: Only use Arctic fuels when the temperature is below 0 °C (32 °F). Do not use Arctic fuels when the ambient temperature is above 0 °C (32 °F). To ensure that the time period between cranking the engine and first fire is kept to a minimum, only use fuel of the correct viscosity and at the correct temperature.

Gas oil to "BS2869 Class A2"

"ASTM D975 - 91 Class 2D" This can only be used if the fuel has the correct specification of lubricity.

"JIS K2204 (1992) Grades 1,2,3 and Special Grade 3" This can only be used if the fuel has the correct specification of lubricity.

Note: If low sulfur or low sulfur aromatic fuels are used, then fuel additives can be used to increase lubricity.

Group 2 (permissible fuels): Specification

These fuel specifications are considered acceptable for issues of warranty. However, these fuels may reduce the life of the engine, the engine's maximum power and the engine's fuel efficiency.

"ASTM D975 - 91 Class 1D"

"JP7, Mil T38219"

"NATO F63"

NOTICE

These fuels should have a wear scar value of 650 micrometers maximum "HFRR to ISO 12156 - 1" and can only be used on VP30 24 volt specifications.

Group 3 (aviation kerosene fuels): Specification

These fuels need additives to achieve lubricity of 650 micrometers wear scar and the reliability of the fuel injection pump will be reduced. The fuel injection pump is not covered by a warranty, even when the additives are included.

“JP5 MIL T5624 (Avcat FSII, NATO F44”

“JP8 T83133 (Avtur FSII, NATO F34”

“Jet A”

“Jet A1, NATO F35, XF63”

Low temperature fuels

Special fuels for use in cold weather may be available for engine operation at temperatures below 0 °C (32 °F). These fuels limit the formation of wax in the fuel oil at low temperatures. If wax forms in the fuel oil, this could stop the flow of fuel oil through the filter.

Note: These fuels that lack lubricity may cause the following problems:

- Low engine power
- Difficult starting in hot conditions or in cold conditions
- White smoke
- Deterioration of emissions and misfire at certain operating conditions

Biofuel: Specification

Biofuel: A 5% mix of RME to EN14214 in conventional fuel is permitted.

NOTICE

Water emulsion fuels: These fuels are not permitted

Refer to the following fuel specifications for North America.

The preferred fuels provide maximum engine service life and performance. The preferred fuels are distillate fuels. These fuels are commonly called diesel fuel or gas oil.

The permissible fuels are crude oils or blended fuels. Use of these fuels can result in higher maintenance costs and in reduced engine service life.

Diesel fuels that meet the specifications in Table 5 will help to provide maximum engine service life and performance. In North America, diesel fuel that is identified as No. 2-D in “ASTM D975” generally meets the specifications. Table 5 is for diesel fuels that are distilled from crude oil. Diesel fuels from other sources could exhibit detrimental properties that are not defined or controlled by this specification.

Table 5

Perkins Specifications for Distillate Diesel Fuel		
Specifications	Requirements	ASTM Test
Aromatics	35% maximum	“D1319”
Ash	0.02% maximum (weight)	“D482”
Carbon Residue on 10% Bottoms	0.35% maximum (weight)	“D524”
Cetane Number	40 minimum (DI engines)	“D613”
Cloud Point	The cloud point must not exceed the lowest expected ambient temperature.	-
Copper Strip Corrosion	No. 3 maximum	“D130”
Distillation	10% at 282 °C (540 °F) maximum	“D86”
	90% at 360 °C (680 °F) maximum	
Flash Point	legal limit	“D93”
API Gravity	30 minimum	“D287”
	45 maximum	
Pour Point	6 °C (10 °F) minimum below ambient temperature	“D97”
Sulfur ⁽¹⁾	0.2% maximum	“D3605” or “D1552”
Kinematic Viscosity ⁽²⁾	2.0 cSt minimum and 4.5 cSt maximum at 40 °C (104 °F)	“D445”
Water and Sediment	0.1% maximum	“D1796”
Water	0.1% maximum	“D1744”
Sediment	0.05% maximum (weight)	“D473”

(continued)

(Table 5, contd)

Gum and Resins (3)	10 mg per 100 mL maximum	"D381"
Lubricity (4)	0.38 mm (0.015 inch) maximum at 25 °C (77 °F)	"D6079"

- (1) Perkins fuel systems and engine components can operate on high sulfur fuels. Fuel sulfur levels affect exhaust emissions. High sulfur fuels also increase the potential for corrosion of internal components. Fuel sulfur levels above 0.5 percent may significantly shorten the oil change interval. For additional information, see this publication, "Engine Oil" topic (Maintenance Section).
- (2) The values of the fuel viscosity are the values as the fuel is delivered to the fuel injection pumps. If a fuel with a low viscosity is used, cooling of the fuel may be required to maintain a 1.4 cSt viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters in order to bring down the viscosity to a 20 cSt viscosity.
- (3) Follow the test conditions and procedures for gasoline (motor).
- (4) The lubricity of a fuel is a concern with low sulfur fuel. To determine the lubricity of the fuel, use either the "ASTM D6078 Scuffing Load Wear Test (SBOCLE)" or the "ASTM D6079 High Frequency Reciprocating Rig (HFRR)" test. If the lubricity of a fuel does not meet the minimum requirements, consult your fuel supplier. Do not treat the fuel without consulting the fuel supplier. Some additives are not compatible. These additives can cause problems in the fuel system.

NOTICE

Operating with fuels that do not meet the Perkins recommendations can cause the following effects: Starting difficulty, poor combustion, deposits in the fuel injectors, reduced service life of the fuel system, deposits in the combustion chamber, and reduced service life of the engine.

NOTICE

Heavy Fuel Oil (HFO), Residual fuel, or Blended fuel must NOT be used in Perkins diesel engines. Severe component wear and component failures will result if HFO type fuels are used in engines that are configured to use distillate fuel.

In extreme cold ambient conditions, you may use the distillate fuels that are specified in Table 6. However, the fuel that is selected must meet the requirements that are specified in Table 5. These fuels are intended to be used in operating temperatures that are down to -54 °C (-65 °F).

Table 6

Distillate Fuels (1)	
Specification	Grade
"MIL-T-5624R"	JP-5
"ASTM D1655"	Jet-A-1
"MIL-T-83133D"	JP-8

- (1) The fuels that are listed in this Table may not meet the requirements that are specified in the "Perkins Specifications for Distillate Diesel Fuel" Table. Consult the supplier for the recommended additives in order to maintain the proper fuel lubricity.

These fuels are lighter than the No. 2 grades of fuel. The cetane number of the fuels in Table 6 must be at least 40. If the viscosity is below 1.4 cSt at 38 °C (100 °F), use the fuel only in temperatures below 0 °C (32 °F). Do not use any fuels with a viscosity of less than 1.2 cSt at 38 °C (100 °F). Fuel cooling may be required in order to maintain the minimum viscosity of 1.4 cSt at the fuel injection pump.

There are many other diesel fuel specifications that are published by governments and by technological societies. Usually, those specifications do not review all the requirements that are addressed in this specification. To ensure optimum engine performance, a complete fuel analysis should be obtained before engine operation. The fuel analysis should include all of the properties that are listed in Table 5.

Cooling System Specifications

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General Coolant Information

NOTICE

Never add coolant to an overheated engine. Engine damage could result. Allow the engine to cool first.

NOTICE

If the engine is to be stored in, or shipped to an area with below freezing temperatures, the cooling system must be either protected to the lowest outside temperature or drained completely to prevent damage.

NOTICE

Frequently check the specific gravity of the coolant for proper freeze protection or for anti-boil protection.

Clean the cooling system for the following reasons:

- Contamination of the cooling system
- Overheating of the engine
- Foaming of the coolant

NOTICE

Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without water temperature regulators.

Many engine failures are related to the cooling system. The following problems are related to cooling system failures: Overheating, leakage of the water pump, and plugged radiators or heat exchangers.

These failures can be avoided with proper cooling system maintenance. Cooling system maintenance is as important as maintenance of the fuel system and the lubrication system. Quality of the coolant is as important as the quality of the fuel and the lubricating oil.

Coolant is normally composed of three elements: Water, additives, and glycol.

Water

Water is used in the cooling system in order to transfer heat.

Distilled water or deionized water is recommended for use in engine cooling systems.

DO NOT use the following types of water in cooling systems: Hard water, softened water that has been conditioned with salt, and sea water.

If distilled water or deionized water is not available, use water with the properties that are listed in Table 7.

Table 7

Perkins Minimum Acceptable Water Requirements	
Property	Maximum Limit
Chloride (Cl)	40 mg/L
Sulfate (SO ₄)	100 mg/L
Total Hardness	170 mg/L
Total Solids	340 mg/L
Acidity	pH of 5.5 to 9.0

For a water analysis, consult one of the following sources:

- Local water utility company
- Agricultural agent
- Independent laboratory

Additives

Additives help to protect the metal surfaces of the cooling system. A lack of coolant additives or insufficient amounts of additives enable the following conditions to occur:

- Corrosion
- Formation of mineral deposits
- Rust
- Scale
- Foaming of the coolant

Many additives are depleted during engine operation. These additives must be replaced periodically.

Additives must be added at the proper concentration. Overconcentration of additives can cause the inhibitors to drop out-of-solution. The deposits can enable the following problems to occur:

- Formation of gel compounds
- Reduction of heat transfer
- Leakage of the water pump seal
- Plugging of radiators, coolers, and small passages

Glycol

Glycol in the coolant helps to provide protection against the following conditions:

- Boiling
- Freezing
- Cavitation of the water pump

For optimum performance, Perkins recommends a 1:1 mixture of a water/glycol solution.

Note: Use a mixture that will provide protection against the lowest ambient temperature.

Note: 100 percent pure glycol will freeze at a temperature of -23°C (-9°F).

Most conventional coolant/antifreezes use ethylene glycol. Propylene glycol may also be used. In a 1:1 mixture with water, ethylene and propylene glycol provide similar protection against freezing and boiling. See Tables 8 and 9.

Table 8

Ethylene Glycol		
Concentration	Freeze Protection	Boil Protection
50 Percent	-36°C (-33°F)	106°C (223°F)
60 Percent	-51°C (-60°F)	111°C (232°F)

NOTICE

Do not use propylene glycol in concentrations that exceed 50 percent glycol because of propylene glycol's reduced heat transfer capability. Use ethylene glycol in conditions that require additional protection against boiling or freezing.

Table 9

Propylene Glycol		
Concentration	Freeze Protection	Anti-Boil Protection
50 Percent	-29°C (-20°F)	106°C (223°F)

To check the concentration of glycol in the coolant, measure the specific gravity of the coolant.

Coolant Recommendations

The antifreeze that is used must meet the standard of corrosion protection that is specified in one of the following specifications:

“BS 6580 - 1992”

“ASTM D3306”

These specifications define the requirements for commercial antifreeze. It is also acceptable to use an antifreeze that has been designed for use in a heavy-duty application.

The manufacturers recommendations for the maintenance of the coolant and the replacement of the coolant must be followed at all times.

Failure to follow these requirements may invalidate any warranty claim.

Refill Capacities

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Refill Capacities

Lubrication System

The refill capacities for the engine crankcase reflect the approximate capacity of the crankcase or sump plus standard oil filters. Auxiliary oil filter systems will require additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter. Refer to the Operation and Maintenance Manual, "Maintenance Section" for more information on Lubricant Specifications.

1106 Electronic Engine

Table 10

1106 Electronic Engine		
Compartment or System	Liters	Quarts
Standard Oil Sump for the Engine Crankcase ⁽¹⁾	13.1	14

⁽¹⁾ These values are the approximate capacities for the crankcase oil sump which include the standard factory installed oil filters. Engines with auxiliary oil filters will require additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.

Cooling System

To maintain the cooling system, the Total Cooling System capacity must be known. The approximate capacity for the engine cooling system is listed below. External System capacities will vary among applications. Refer to the OEM specifications for the External System capacity. This capacity information will be needed in order to determine the amount of coolant/antifreeze that is required for the Total Cooling System.

1106 Electronic Engine

Table 11

1106 Electronic Turbocharged Engine		
Compartment or System	Liters	Quarts
Engine Only	15.1	16
External cooling System (OEM recommendation) ⁽¹⁾		
Total Cooling System ⁽²⁾		

⁽¹⁾ The external cooling system includes a radiator or an expansion tank with the following components: Heat exchanger, aftercooler, and piping. Refer to Perkins specifications and/or the OEM specifications. Enter the value for the external cooling system capacity in this row.

⁽²⁾ The Total Cooling System includes the capacity for the engine cooling system plus the capacity for the external cooling system. Enter the total in this row.

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Maintenance Interval Schedule

Ensure that the Safety Information, Warnings, and Instructions are read and understood before operation or maintenance procedures are performed.

Before each consecutive interval is performed, all of the maintenance requirements from the previous interval must also be performed.

Note: For engine cooling systems that contain Perkins antifreeze, replace the coolant in the engine cooling system at 2 yearly intervals. For engine cooling systems that contain an inhibitor, replace the coolant in the engine cooling system at 6 monthly intervals.

When Required

Battery - Replace	55
Battery or Battery Cable - Disconnect	56
Engine - Clean	59
Engine Air Cleaner Element (Dual Element) - Clean/Replace	59
Engine Oil Sample - Obtain	64
Fuel Injection Nozzles - Test/Exchange	67
Fuel System - Prime	68
Severe Service Application - Check	74

Daily

Cooling System Coolant Level - Check	57
Driven Equipment - Check	59
Engine Air Cleaner Service Indicator - Inspect	61
Engine Oil Level - Check	64
Fuel System Primary Filter/Water Separator - Drain	69
Walk-Around Inspection	76

Every 500 Service Hours or 1 Year

Air Compressor Filter - Clean/Replace	54
Alternator and Fan Belts - Inspect/Adjust/ Replace	54
Battery Electrolyte Level - Check	55
Cooling System Coolant - Test/Add	57
Cylinder Head Grounding Stud - Inspect/Clean/ Tighten	58
Engine Air Cleaner Element (Dual Element) - Clean/Replace	59
Engine Crankcase Breather Element - Replace ...	63
Engine Oil and Filter - Change	65
Engine Protective Devices - Check	66
Fuel System Primary Filter/Water Separator Element - Replace	70
Fuel System Secondary Filter - Replace	71
Fuel Transfer Pump Strainer - Clean	71

Hoses and Clamps - Inspect/Replace	72
Radiator - Clean	73

Every 1000 Service Hours

Engine Valve Lash - Inspect/Adjust	67
Valve Mechanism Cover Seal - Check	76

Every 2000 Service Hours

Aftercooler Core - Inspect	53
Alternator - Inspect	54
Crankshaft Vibration Damper - Inspect	58
Engine Mounts - Inspect	63
Starting Motor - Inspect	74
Turbocharger - Inspect	75
Water Pump - Inspect	77

Every 2 Years

Cooling System Coolant - Change	56
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Every 4000 Service Hours

Aftercooler Core - Clean/Test	53
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Every 8000 Service Hours

Engine Crankcase Breather - Replace	62
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Aftercooler Core - Clean/Test

1. Remove the core. Refer to the OEM information for the correct procedure.
2. Turn the aftercooler core upside-down in order to remove debris.

NOTICE

Do not use a high concentration of caustic cleaner to clean the core. A high concentration of caustic cleaner can attack the internal metals of the core and cause leakage. Only use the recommended concentration of cleaner.

3. Back flush the core with a suitable cleaner.
4. Steam clean the core in order to remove any residue. Flush the fins of the aftercooler core. Remove any other trapped debris.
5. Wash the core with hot, soapy water. Rinse the core thoroughly with clean water.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

6. Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.
7. Inspect the core in order to ensure cleanliness. Pressure test the core. If necessary, repair the core.
8. Install the core. Refer to the OEM information for the correct procedure.

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Aftercooler Core - Inspect

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the aftercooler for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the aftercooler, if necessary.

For air-to-air aftercoolers, use the same methods that are used for cleaning radiators.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a "comb".

Note: If parts of the aftercooler system are repaired or replaced, a leak test is highly recommended.

Inspect these items for good condition: Welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

i01909950

Air Compressor Filter - Clean/Replace (If Equipped)

One of the single most important aspects of preventive maintenance for the air compressor is the induction of clean air. The type of maintenance that is required for the air compressor and the maintenance interval depends on the type of air induction system that is used. Operating conditions (dust, dirt and debris) may require more frequent service.

Refer to the OEM information for the correct procedure.

For applications that require multiple drive belts, replace the belts in matched sets. Replacing only one belt of a matched set will cause the new belt to carry more load because the older belt is stretched. The additional load on the new belt could cause the new belt to break.

If the belts are too loose, vibration causes unnecessary wear on the belts and pulleys. Loose belts may slip enough to cause overheating.

To accurately check the belt tension, a suitable gauge should be used. Refer to the Disassembly and Assembly manual for the correct procedure. If a suitable gauge is not available, apply 45 N (10 lb ft) of force midway between the pulleys. A correctly adjusted belt will deflect 10 mm (0.39 inch).

Adjustment

i01908658

Alternator - Inspect

Perkins recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and proper battery charging. Inspect the ammeter (if equipped) during engine operation in order to ensure proper battery performance and/or proper performance of the electrical system. Make repairs, as required.

Check the alternator and the battery charger for proper operation. If the batteries are properly charged, the ammeter reading should be very near zero. All batteries should be kept charged. The batteries should be kept warm because temperature affects the cranking power. If the battery is too cold, the battery will not crank the engine. When the engine is not run for long periods of time or if the engine is run for short periods, the batteries may not fully charge. A battery with a low charge will freeze more easily than a battery with a full charge.

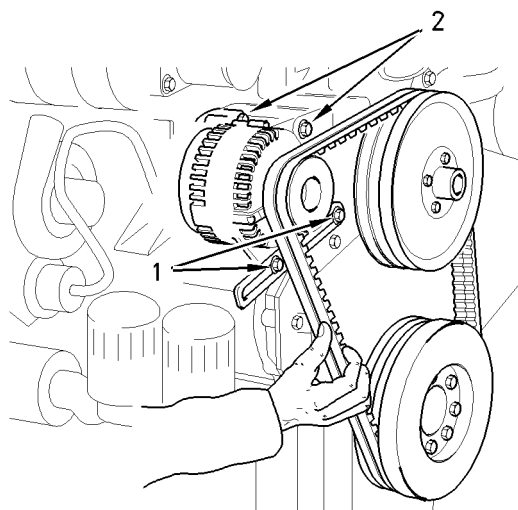


Illustration 21

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Typical example

- (1) Adjusting bolts
- (2) Mounting bolts

Alternator and Fan Belts - Inspect/Adjust/Replace

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Inspection

To maximize the engine performance, inspect the belts for wear and for cracking. Replace belts that are worn or damaged.

1. Loosen the mounting bolts (2) and the adjusting bolts (1).
2. Move the alternator in order to increase or decrease the belt tension.
3. Tighten the adjusting bolts (1). Tighten the mounting bolts (2). Refer to the Specifications Manual for the correct torque settings.

Replacement

Refer to the Disassembly and Assembly manual for the installation procedure and the removal procedure for the belts.

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Battery - Replace

WARNING

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Turn the key start switch to the OFF position. Remove the key and all electrical loads.
2. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the ground plane. Disconnect the cable from the NEGATIVE “-” battery terminal.
3. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.

Note: Always recycle a battery. Never discard a battery. Return used batteries to an appropriate recycling facility.

4. Remove the used battery.
5. Install the new battery.

Note: Before the cables are connected, ensure that the key start switch is OFF.

6. Connect the cable from the starting motor to the POSITIVE “+” battery terminal.
7. Connect the cable from the ground plane to the NEGATIVE “-” battery terminal.

Battery Electrolyte Level - Check

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing. If batteries are properly charged, ammeter reading should be very near zero.

WARNING

All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.

1. Remove the filler caps. Maintain the electrolyte level to the “FULL” mark on the battery.

If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

2. Check the condition of the electrolyte with a suitable battery tester.
3. Keep the batteries clean.

Clean the battery case with one of the following cleaning solutions:

- A mixture of 0.1 kg (0.2 lb) of baking soda and 1 L (1 qt) of clean water
- A mixture of 0.1 L (0.11 qt) of ammonia and 1 L (1 qt) of clean water

Thoroughly rinse the battery case with clean water.

Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit properly. Coat the clamps and the terminals with a suitable silicone lubricant or petroleum jelly.

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Battery or Battery Cable - Disconnect

WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.
2. Disconnect the negative battery terminal at the battery that goes to the start switch. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, the negative side of two batteries must be disconnected.
3. Tape the leads in order to help prevent accidental starting.
4. Proceed with necessary system repairs. Reverse the steps in order to reconnect all of the cables.

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Cooling System Coolant - Change

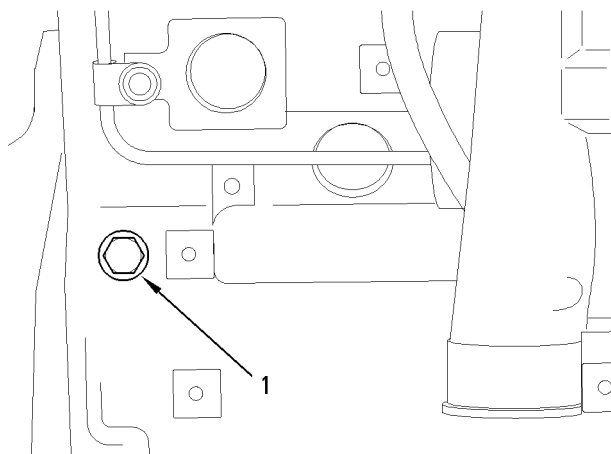


Illustration 22

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NOTICE

Do not drain the coolant while the engine is still hot and the system is under pressure because dangerous hot coolant can be discharged.

Note: The radiator may not have been provided by Perkins. The following is a general procedure for changing the coolant. Refer to the OEM information for the correct procedure.

1. Ensure that the vehicle is on level ground.
2. Remove the filler cap of the cooling system.
3. Remove the drain plug (1) from the side of the cylinder block in order to drain the engine. Ensure that the drain hole is not restricted.
4. Open the radiator drain tap or remove the drain plug at the bottom of the radiator in order to drain the radiator. If the radiator does not have a radiator drain tap or a drain plug, disconnect the hose at the bottom of the radiator.
5. Flush the coolant system with clean water.
6. Install the drain plugs and close the radiator drain tap. Install the radiator hose if the radiator hose was previously removed.

7. Fill the system with an approved antifreeze mixture. Install the filler cap.
8. Run the engine and check for coolant leaks.

i01914623

Cooling System Coolant - Test/Add

Check the specific gravity of the coolant

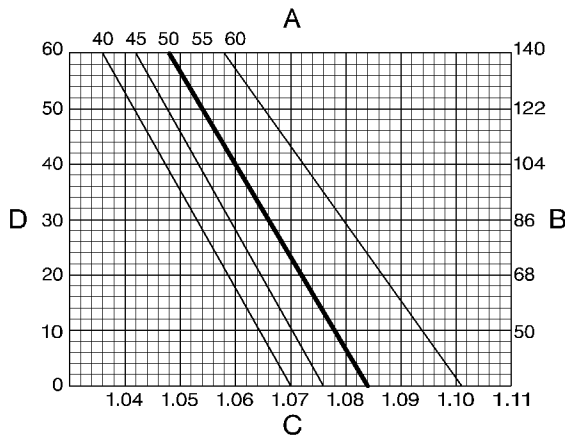


Illustration 23

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The chart for the Specific gravity

A = Percentage of antifreeze by volume

B = The temperature of the mixture in °F

C = Specific gravity

E = The temperature of the solution in °C

The following procedure must be used to measure coolant that contains antifreeze:

1. Ensure that the engine is on level ground.
2. Operate the engine until the coolant temperature opens the thermostat. Continue to run the engine until the coolant has circulated around the cooling system.
3. Stop the engine.
4. Allow the engine to cool until the temperature is below 60 °C (140 °F).

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

5. Remove the filler cap of the cooling system.
6. Drain some of the coolant from the cooling system into a suitable container.
7. Use a special hydrometer that will check the temperature and the specific gravity of the coolant, and follow the manufacturer's instructions.

Note: If a special thermo-hydrometer for coolant is not available, put an hydrometer and a separate thermometer into the antifreeze mixture and check the readings on both instruments. Compare the readings with the data in illustration 23.

Note: If necessary, fill the system or replenish the coolant in the system with premixed coolant of the correct strength. Perkins POWERPART antifreeze with a concentration of 50% will give protection against frost to a temperature of -35 °C (-31 °F). The solution will also protect against corrosion. This is especially important when there are aluminum components in the cooling circuit.

8. Adjust the strength of the mixture if it is necessary.

i01920057

Cooling System Coolant Level - Check

Note: The cooling system may not have been provided by Perkins. The procedure that follows is for a typical cooling system. Refer to the OEM information for the correct procedures.

Check the coolant level when the engine is stopped and cool.

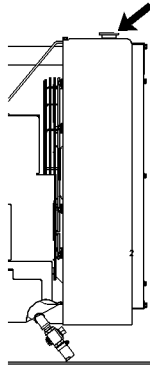


Illustration 24
Cooling system filler cap

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WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Remove the cooling system filler cap slowly in order to relieve pressure.
2. Maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level to the proper level in the sight glass.

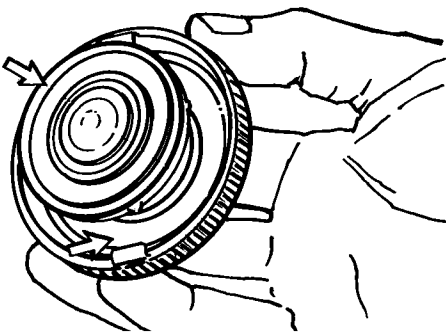


Illustration 25
Typical filler cap gaskets

g00103639

3. Clean the cooling system filler cap and check the condition of the filler cap gaskets. Replace the cooling system filler cap if the filler cap gaskets are damaged. Reinstall the cooling system filler cap.
4. Inspect the cooling system for leaks.

i01196868

Crankshaft Vibration Damper - Inspect

Damage to the crankshaft vibration damper or failure of the crankshaft vibration damper can increase torsional vibrations. This can result in damage to the crankshaft and to other engine components. A deteriorating damper can cause excessive gear train noise at variable points in the speed range.

The damper is mounted to the crankshaft which is located behind the belt guard on the front of the engine.

Removal and Installation

Refer to the Service Manual for the damper removal procedure and for the damper installation procedure.

i01908650

Cylinder Head Grounding Stud - Inspect/Clean/Tighten

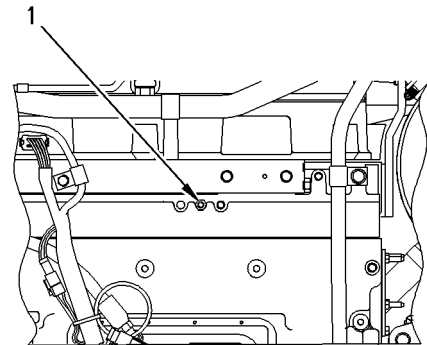


Illustration 26

g00738038

Typical example for location of cylinder head grounding stud
(1) Cylinder head grounding stud

Inspect the wiring harness for good connections.

If the cylinder head grounding stud is installed, the cylinder head grounding stud must have a wire ground to the battery. Tighten the cylinder head grounding stud at every oil change. Ground wires and straps should be combined at engine grounds. All grounds should be tight and free of corrosion.

- Clean the cylinder head grounding stud and the terminals with a clean cloth.

- If the connections are corroded, clean the connections with a solution of baking soda and water.
- Keep the cylinder head grounding stud and the strap clean and coated with suitable grease or petroleum jelly.

i00174798

Driven Equipment - Check

Refer to the OEM specifications for more information on the following maintenance recommendations for the driven equipment:

- Inspection
- Adjustment
- Lubrication
- Other maintenance recommendations

Perform any maintenance for the driven equipment which is recommended by the OEM.

i01909392

Engine - Clean

WARNING

Personal injury or death can result from high voltage.

Moisture can create paths of electrical conductivity.

Make sure that the electrical system is OFF. Lock out the starting controls and tag the controls "DO NOT OPERATE".

NOTICE

Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

NOTICE

Failure to protect some engine components from washing may make your engine warranty invalid. Allow the engine to cool for one hour before washing the engine.

Periodic cleaning of the engine is recommended. Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

Note: Caution must be used in order to prevent electrical components from being damaged by excessive water when the engine is cleaned. Pressure washers and steam cleaners should not be directed at any electrical connectors or the junction of cables into the rear of the connectors. Avoid electrical components such as the alternator, the starter, and the ECM. Protect the fuel injection pump from fluids in order to wash the engine.

i01915869

Engine Air Cleaner Element (Dual Element) - Clean/Replace

NOTICE

Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent airborne debris from entering the air inlet.

NOTICE

Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

Servicing the Air Cleaner Elements

Note: The air filter system may not have been provided by Perkins. The procedure that follows is for a typical air filter system. Refer to the OEM information for the correct procedure.

If the air cleaner element becomes plugged, the air can split the material of the air cleaner element. Unfiltered air will drastically accelerate internal engine wear. Refer to the OEM information for the correct air cleaner elements for your application.

- Check the precleaner (if equipped) and the dust bowl daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.

- Operating conditions (dust, dirt and debris) may require more frequent service of the air cleaner element.
- The air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Replace the dirty air cleaner elements with clean air cleaner elements. Before installation, the air cleaner elements should be thoroughly checked for tears and/or holes in the filter material. Inspect the gasket or the seal of the air cleaner element for damage. Maintain a supply of suitable air cleaner elements for replacement purposes.

Dual Element Air Cleaners

The dual element air cleaner contains a primary air cleaner element and a secondary air cleaner element. The primary air cleaner element can be used up to six times if the element is properly cleaned and properly inspected. The primary air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

The secondary air cleaner element is not serviceable or washable. Refer to the OEM information for instructions in order to replace the secondary air cleaner element. When the engine is operating in environments that are dusty or dirty, air cleaner elements may require more frequent replacement.

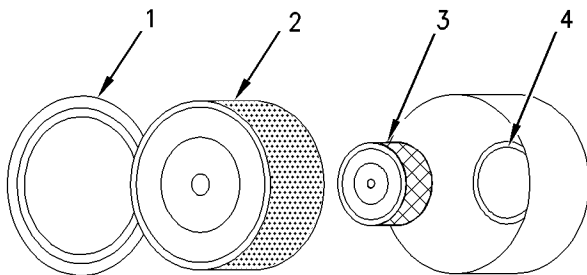


Illustration 27

g00736431

- (1) Cover
(2) Primary air cleaner element
(3) Secondary air cleaner element
(4) Air inlet

1. Remove the cover. Remove the primary air cleaner element.
2. The secondary air cleaner element should be removed and discarded for every three cleanings of the primary air cleaner element.

Note: Refer to “Cleaning the Primary Air Cleaner Elements”.

3. Cover the air inlet with tape in order to keep dirt out.
4. Clean the inside of the air cleaner cover and body with a clean, dry cloth.
5. Remove the tape for the air inlet. Install the secondary air cleaner element. Install a primary air cleaner element that is new or cleaned.
6. Install the air cleaner cover.
7. Reset the air cleaner service indicator.

Cleaning the Primary Air Cleaner Elements

NOTICE

Observe the following guidelines if you attempt to clean the filter element:

Do not tap or strike the filter element in order to remove dust.

Do not wash the filter element.

Use low pressure compressed air in order to remove the dust from the filter element. Air pressure must not exceed 207 kPa (30 psi). Direct the air flow up the pleats and down the pleats from the inside of the filter element. Take extreme care in order to avoid damage to the pleats.

Do not use air filters with damaged pleats, gaskets, or seals. Dirt entering the engine will cause damage to engine components.

Refer to the OEM information in order to determine the number of times that the primary filter element can be cleaned. When the primary air cleaner element is cleaned, check for rips or tears in the filter material. The primary air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

NOTICE

Do not clean the air cleaner elements by bumping or tapping. This could damage the seals. Do not use elements with damaged pleats, gaskets or seals. Damaged elements will allow dirt to pass through. Engine damage could result.

Visually inspect the primary air cleaner elements before cleaning. Inspect the air cleaner elements for damage to the seal, the gaskets, and the outer cover. Discard any damaged air cleaner elements.

There are two common methods that are used to clean primary air cleaner elements:

- Pressurized air
- Vacuum cleaning

Pressurized Air

Pressurized air can be used to clean primary air cleaner elements that have not been cleaned more than two times. Pressurized air will not remove deposits of carbon and oil. Use filtered, dry air with a maximum pressure of 207 kPa (30 psi).

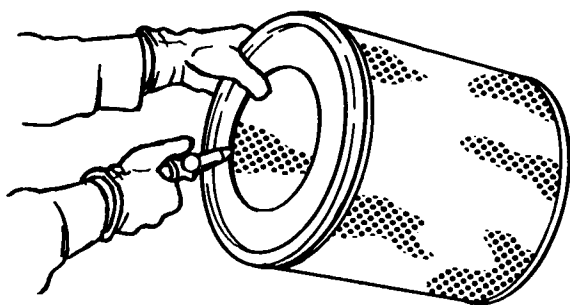


Illustration 28

g00281692

Note: When the primary air cleaner elements are cleaned, always begin with the clean side (inside) in order to force dirt particles toward the dirty side (outside).

Aim the hose so that the air flows inside the element along the length of the filter in order to help prevent damage to the paper pleats. Do not aim the stream of air directly at the primary air cleaner element. Dirt could be forced further into the pleats.

Note: Refer to “Inspecting the Primary Air Cleaner Elements”.

Vacuum Cleaning

Vacuum cleaning is a good method for cleaning primary air cleaner elements which require daily cleaning because of a dry, dusty environment. Cleaning with pressurized air is recommended prior to vacuum cleaning. Vacuum cleaning will not remove deposits of carbon and oil.

Note: Refer to “Inspecting the Primary Air Cleaner Elements”.

Inspecting the Primary Air Cleaner Elements

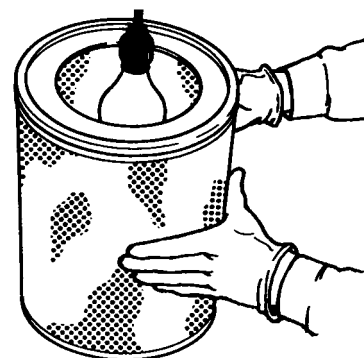


Illustration 29

g00281693

Inspect the clean, dry primary air cleaner element. Use a 60 watt blue light in a dark room or in a similar facility. Place the blue light in the primary air cleaner element. Rotate the primary air cleaner element. Inspect the primary air cleaner element for tears and/or holes. Inspect the primary air cleaner element for light that may show through the filter material. If it is necessary in order to confirm the result, compare the primary air cleaner element to a new primary air cleaner element that has the same part number.

Do not use a primary air cleaner element that has any tears and/or holes in the filter material. Do not use a primary air cleaner element with damaged pleats, gaskets or seals. Discard damaged primary air cleaner elements.

i01909507

Engine Air Cleaner Service Indicator - Inspect

Some engines may be equipped with a different service indicator.

Some engines are equipped with a differential gauge for inlet air pressure. The differential gauge for inlet air pressure displays the difference in the pressure that is measured before the air cleaner element and the pressure that is measured after the air cleaner element. As the air cleaner element becomes dirty, the pressure differential rises. If your engine is equipped with a different type of service indicator, follow the OEM recommendations in order to service the air cleaner service indicator.

The service indicator may be mounted on the air cleaner element or in a remote location.

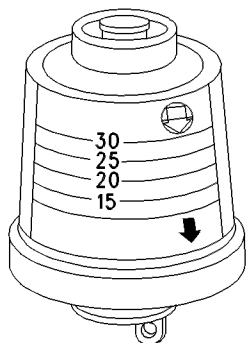


Illustration 30

g00103777

Typical service indicator

Observe the service indicator. The air cleaner element should be cleaned or the air cleaner element should be replaced when one of the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.

Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.
- Check the movement of the yellow core when the engine is accelerated to the engine rated speed. The yellow core should latch approximately at the greatest vacuum that is attained.

If the service indicator does not reset easily, or if the yellow core does not latch at the greatest vacuum, the service indicator should be replaced. If the new service indicator will not reset, the hole for the service indicator may be restricted.

The service indicator may need to be replaced frequently in environments that are severely dusty.

Engine Crankcase Breather - Replace

1106 Engines

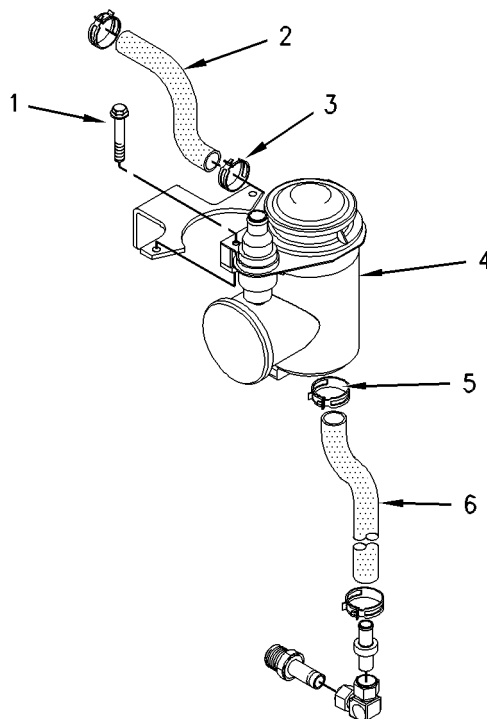


Illustration 31

g00997888

1106 Closed breather system

- (1) Fastening bolt
- (2) Top hose
- (3) Top hose clamp
- (4) Breather assembly
- (5) Bottom hose clamp
- (6) Bottom hose

Remove the breather assembly

1. Loosen the top hose clamp (3) and the bottom hose clamp (5). Remove both the hoses (2) and (6) from the breather assembly (4).
2. Remove the outlet hose (not shown) for the breather .
3. Remove the two bolts (1) and remove the breather assembly from the engine.

Install the breather assembly

1. Install the new breather assembly, by fastening the two bolts (1). Refer to Torque Specifications Manual, "Standard torque for Metric Fasteners" for the correct torque.
2. Install the top hose (2) and the bottom hose (6), and tighten both clamps (3 and 5). Refer to the Torque Specifications Manual, "Standard Torque for Constant Torque Hose Clamps" for the correct torques.
3. Install the outlet hose (not shown) for the breather.

i01914587

Engine Crankcase Breather Element - Replace

1106 Engines

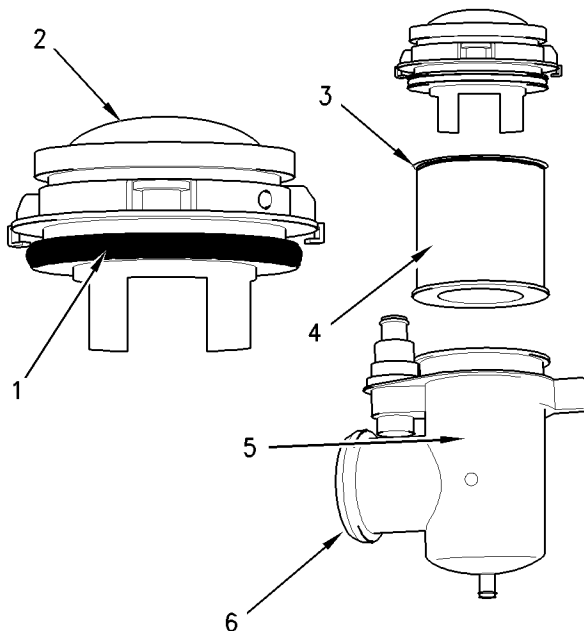


Illustration 32

g00997911

The breather element

- (1) The O-ring for the top cover
- (2) The top cover
- (3) The O-ring for the filter element
- (4) The filter element
- (5) The breather body
- (6) The side cover

NOTICE

Ensure that the components of the breather assembly are installed in the correct positions. If installed incorrectly, engine damage can result.

Note: If necessary, remove the breather assembly. Refer to OMM, "Engine Crankcase Breather Replace".

Note: There are several vent holes under the top cover (2) and under the side cover (6). Keep the area around the vent holes clean. Do not restrict the vent holes.

1. Remove all dirt and oil from the breather assembly. Remove the top cover (2) by turning the top cover counterclockwise until the lugs disengage. The breather element includes an O ring. Remove the breather element (4) by turning and lifting the element. Discard the element. Clean the inner surfaces of the breather body (5). Clean the top cover and inspect the O ring (1) in the top cover. If the O ring for the top cover is worn or damaged, replace the O ring.
2. Lubricate the O ring (3) in the new filter element (4) with clean engine lubricating oil. Carefully insert the element into the breather body (5). Lubricate the O ring (1) in the top cover with clean engine lubricating oil. Carefully insert the top cover (2) into the breather body (5). Rotate the top cover clockwise until the lugs are fully locked.

i01908586

Engine Mounts - Inspect

Note: The engine mounts may not have been supplied for this installation by Perkins. Refer to the OEM information for further information on the engine mounts and the correct bolt torque.

Inspect the engine mounts for deterioration and for correct bolt torque. Engine vibration can be caused by the following conditions:

- Improper mounting of the engine
- Deterioration of the engine mounts

Any engine mount that shows deterioration should be replaced. Refer to the OEM information for the recommended torques.

i01907673

Engine Oil Level - Check

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

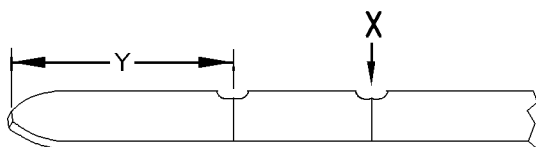


Illustration 33

g00998024

(Y) "ADD" mark. (X) "FULL" mark.

NOTICE

Perform this maintenance with the engine stopped.

Note: Ensure that the engine is either level or that the engine is in the normal operating position in order to obtain a true level indication.

Note: After the engine has been switched OFF, allow the engine oil to drain to the oil pan before checking the oil level.

1. Maintain the oil level between the "ADD" mark (Y) and the "FULL" mark (X) on the engine oil dipstick. Do not fill the crankcase above the "FULL" mark (X).

NOTICE

Operating your engine when the oil level is above the "FULL" mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil's lubricating characteristics and could result in the loss of power.

2. Remove the oil filler cap and add oil, if necessary. Clean the oil filler cap. Install the oil filler cap.

i01907674

Engine Oil Sample - Obtain

The condition of the engine lubricating oil may be checked at regular intervals as part of a preventive maintenance program. Perkins include an oil sampling valve as an option. The oil sampling valve (if equipped) is included in order to regularly sample the engine lubricating oil. The oil sampling valve is positioned on the oil filter head or the oil sampling valve is positioned on the cylinder block.

Perkins recommends using a sampling valve in order to obtain oil samples. The quality and the consistency of the samples are better when a sampling valve is used. The location of the sampling valve allows oil that is flowing under pressure to be obtained during normal engine operation.

Obtain the Sample and the Analysis

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

In order to help obtain the most accurate analysis, record the following information before an oil sample is taken:

- The date of the sample
- Engine model
- Engine number
- Service hours on the engine
- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

Ensure that the container for the sample is clean and dry. Also ensure that the container for the sample is clearly labelled.

To ensure that the sample is representative of the oil in the crankcase, obtain a warm, well mixed oil sample.

To avoid contamination of the oil samples, the tools and the supplies that are used for obtaining oil samples must be clean.

The sample can be checked for the following: the quality of the oil, the existence of any coolant in the oil, the existence of any ferrous metal particles in the oil, and the existence of any nonferrous metal particles in the oil.

i01907675

Engine Oil and Filter - Change

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Do not drain the engine lubricating oil when the engine is cold. As the engine lubricating oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with draining cold oil. Drain the crankcase with the engine stopped. Drain the crankcase with the oil warm. This draining method allows the waste particles that are suspended in the oil to be drained properly.

Failure to follow this recommended procedure will cause the waste particles to be recirculated through the engine lubrication system with the new oil.

Drain the Engine Lubricating Oil

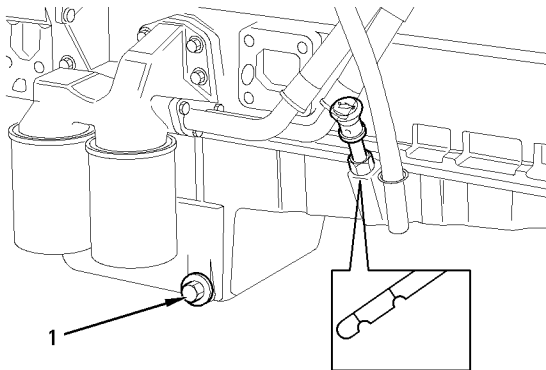


Illustration 34

g00998387

A typical drain plug

Note: Ensure that the vessel that will be used is large enough to collect the waste oil.

After the engine has been run at the normal operating temperature, stop the engine. Use one of the following methods to drain the engine crankcase oil:

- If the engine is equipped with a drain valve, turn the drain valve knob counterclockwise in order to drain the oil. After the oil has drained, turn the drain valve knob clockwise in order to close the drain valve.
- If the engine is not equipped with a drain valve, remove the oil drain plug (1) in order to allow the oil to drain. If the engine is equipped with a shallow sump, remove the bottom oil drain plugs from both ends of the oil pan.

After the oil has drained, the oil drain plugs should be cleaned and installed.

Replace the Oil Filter

NOTICE

Perkins oil filters are manufactured to Perkins specifications. Use of an oil filter that is not recommended by Perkins could result in severe damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Perkins.

1. If two oil filters are installed, remove both the oil filters, with a suitable chain wrench.

Note: The following actions can be carried out as part of the preventive maintenance program.

2. Cut the oil filter open with a suitable tool. Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the oil filter element. Ferrous metals may indicate wear on the steel and cast iron parts of the engine.

Nonferrous metals may indicate wear on the aluminum parts, brass parts or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings, and turbocharger bearings.

Due to normal wear and friction, it is not uncommon to find small amounts of debris in the oil filter.

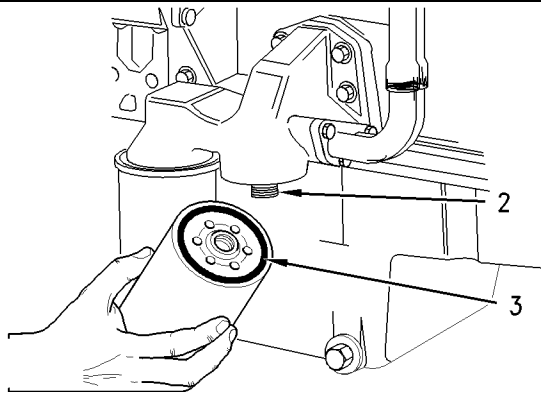


Illustration 35

g00998750

Replace the filter.

3. Clean the sealing surface of the oil filter head. Ensure that the union (2) is secure in the filter head.
4. Apply clean engine oil to the O ring seal (3) for the new oil filter.

NOTICE

Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components.

5. Install the oil filter. Tighten the oil filter by hand according to the instructions that are shown on the oil filter. Do not overtighten the oil filter.

Fill the Engine Crankcase

1. Remove the oil filler cap. Refer to the Operation and Maintenance Manual, "Lubricant Specifications" for more information on suitable oils. Fill the crankcase with the proper amount of new engine lubricating oil. Refer to the Operation and Maintenance Manual, "Lubricant Specifications" for more information on refill capacities.

NOTICE

If equipped with an auxiliary oil filter system or a remote filter system, follow the OEM or the filter manufacturer's recommendations. Under filling or over filling the crankcase with oil can cause engine damage.

2. Start the engine and run the engine at "LOW IDLE" for two minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.

3. Stop the engine and allow the oil to drain back to the sump for a minimum of ten minutes.

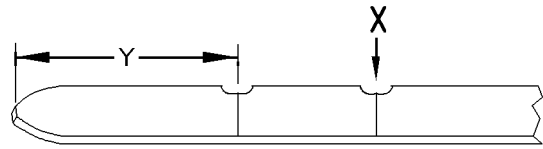


Illustration 36

g00998024

(Y) "ADD" mark. (X) "FULL" mark.

4. Remove the engine oil dipstick in order to check the oil level. Maintain the oil level between the "ADD" and "FULL" marks on the engine oil dipstick.

i01907676

Engine Protective Devices - Check

Alarms and shutoffs (if equipped) must function properly. Alarms provide timely warning to the operator. Shutoffs help to prevent damage to the engine. It is impossible to determine if the engine protective devices are in good working order during normal operation. Malfunctions must be simulated in order to test the engine protective devices.

A calibration check of the engine protective devices will ensure that the alarms and shutoffs activate at the setpoints. Ensure that the engine protective devices are functioning properly. Refer to OEM information for more information.

NOTICE

During testing, abnormal operating conditions must be simulated.

The tests must be performed correctly in order to prevent possible damage to the engine.

To prevent damage to the engine, your authorized Perkins dealer or your Perkins distributor should perform the tests.

Visual Inspection

Visually check the condition of all gauges, sensors and wiring. Look for wiring and components that are loose, broken, or damaged. Damaged wiring or components should be repaired or replaced immediately.

i01933316

Engine Valve Lash - Inspect/Adjust

This maintenance is recommended by Perkins as part of a lubrication and preventive maintenance schedule in order to help provide maximum engine life.

NOTICE

Only qualified service personnel should perform this maintenance. Refer to the Service Manual or your authorized Perkins dealer or your Perkins distributor for the complete valve lash adjustment procedure.

Operation of Perkins engines with incorrect valve lash can reduce engine efficiency, and also reduce engine component life.

WARNING

Ensure that the engine can not be started while this maintenance is being performed. To help prevent possible injury, do not use the starting motor to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting valve lash clearance.

Ensure that the engine is stopped before measuring the valve lash. The engine valve lash can be inspected and adjusted when the temperature of the engine is hot or cold.

Refer to Systems Operation/Testing and Adjusting, "Engine Valve Lash - Inspect/Adjust" for more information.

i01907678

Fuel Injection Nozzles - Test/Exchange

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

NOTICE

If a fuel injector nozzle is suspected of operating outside of normal parameters it should be removed by a qualified technician. The suspect fuel injector nozzle should be taken to an authorized agent for inspection.

Regular maintenance of the fuel injector nozzles is not necessary. The fuel injector nozzles should not be cleaned as cleaning with incorrect tools can damage the nozzle. The fuel injector nozzles should be renewed only if a fault with the fuel injection nozzle occurs. Some of the problems that may indicate that new fuel injection nozzles are needed are listed below:

- The engine will not start or the engine is difficult to start.
- Not enough power
- The engine misfires or the engine runs erratically.
- High fuel consumption
- Black exhaust smoke
- The engine knocks or there is vibration in the engine.
- Excessive engine temperature

Removal and Installation of the Fuel Injection Nozzles

WARNING

Work carefully around an engine that is running. Engine parts that are hot, or parts that are moving, can cause personal injury.

WARNING

Make sure that you wear eye protection at all times during testing. When fuel injection nozzles are tested, test fluids travel through the orifices of the nozzle tip with high pressure. Under this amount of pressure, the test fluid can pierce the skin and cause serious injury to the operator. Always keep the tip of the fuel injection nozzle pointed away from the operator and into the fuel collector and extension.

NOTICE

If your skin comes into contact with high pressure fuel, obtain medical assistance immediately.

Operate the engine at a fast idle speed in order to identify the faulty fuel injector nozzle. Individually loosen and tighten the union nut for the high pressure pipe to each fuel injector nozzle. Do not loosen the union nut more than half a turn. There will be little effect on the engine speed when the union nut to the faulty fuel injection nozzle is loosened. Refer to the Disassembly and Assembly Manual for more information. Consult your authorized Perkins dealer or your Perkins distributor for assistance.

i01907679

Fuel System - Prime

If air enters the fuel system, the air must be purged from the fuel system before the engine can be started. Air can enter the fuel system when the following events occur:

- The fuel tank is empty or the fuel tank has been partially drained.
- The low pressure fuel lines are disconnected.
- A leak exists in the low pressure fuel system.
- The fuel filter has been replaced.

Use the following procedure in order to remove air from the fuel system:

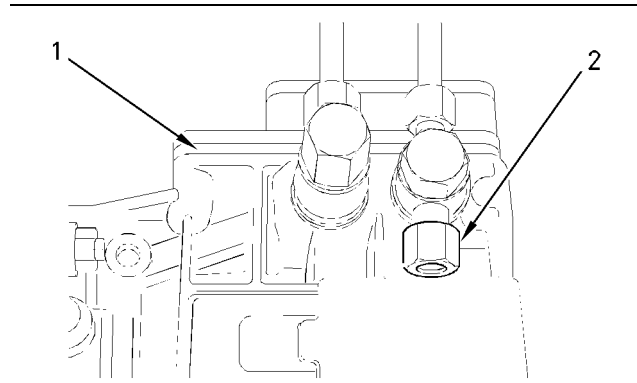


Illustration 37

g00911348

1. Loosen nut (2) on the fuel injection pump (1).

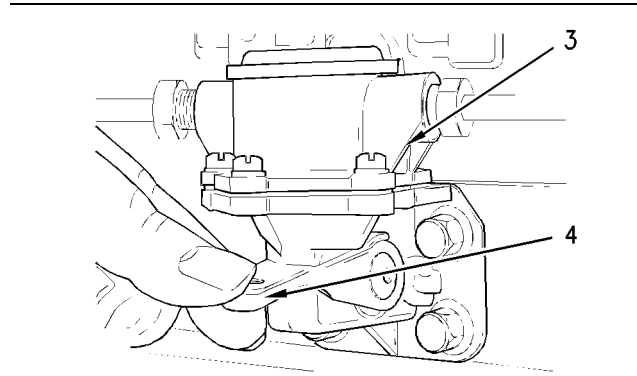


Illustration 38

g00911349

Note: If the drive cam for the fuel priming pump is in the position of maximum cam lift, the priming lever will not operate. Rotate the crankshaft by hand one revolution.

2. Operate the priming lever (4) on the priming pump (3) until the fuel flows out of nut (2) free of air.
3. Tighten nut (2) to a torque of 23 N·m (17 lb ft).

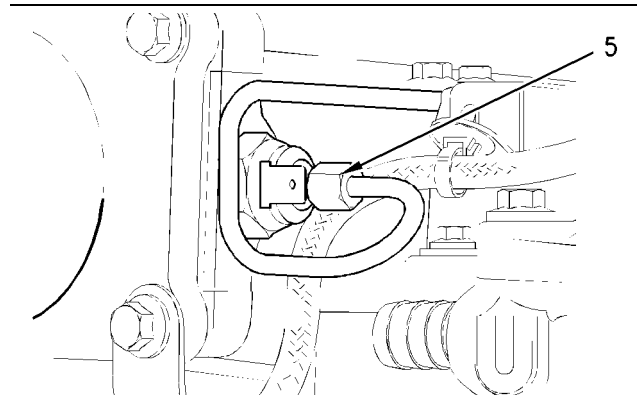


Illustration 39

g00911351

i01907680

4. If the fuel line for the air inlet heater starting aid has been drained, loosen nut (5). Observe the connection at the flare nut. Operate the priming lever on the fuel priming pump until the fuel is free of air.

5. Tighten nut (5) to a torque of 6 N·m (53 lb in).

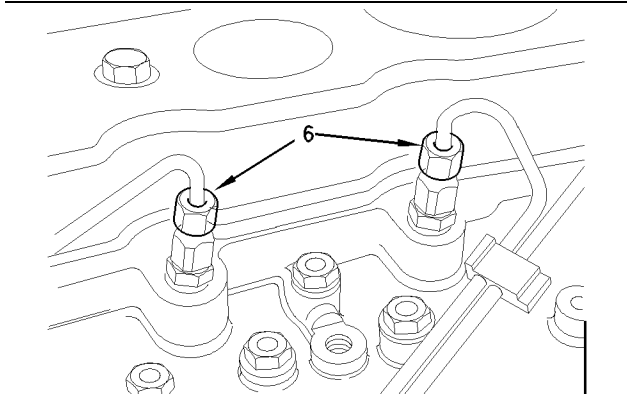


Illustration 40

g00998751

High pressure pipes

Note: Damage to the fuel injection pump, to the battery, and to the starter motor can occur if the starter motor is used excessively to purge the air from the fuel system.

6. Loosen flare nuts (6) for the high pressure fuel lines on all of the fuel injection nozzles.

NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

7. Observe the connection at the flare nut. Refer to the above "NOTICE" and operate the starting motor until the fuel is free of air.
8. Tighten flare nuts (6) to a torque of 27 N·m (20 lb ft).
9. The engine is now ready to start. Operate the engine at low idle for a minimum of five minutes immediately after air has been removed from the fuel system.

Note: Running the engine for this period of time will help ensure that the pump is completely free of air.

Fuel System Primary Filter/Water Separator - Drain

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE

The water separator is not a filter. The water separator separates water from the fuel. The engine should never be allowed to run with the water separator more than half full. Engine damage may result.

The fuel filter/water separator (if equipped) is not usually supplied by Perkins. The following text describes a typical fuel filter/water separator. Refer to the OEM information for further information on the fuel filter/water separator.

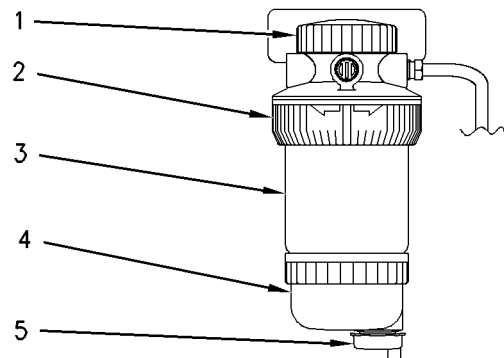


Illustration 41

g00741109

- (1) Cap
- (2) Locking ring
- (3) Element
- (4) Water separator bowl
- (5) Drain

1. Open drain (5). Catch the draining water in a suitable container. Dispose of the drained water properly.
2. Close drain (5).

NOTICE

The water separator is under suction during normal engine operation. Ensure that the drain valve is tightened securely to help prevent air from entering the fuel system.

i01907681

Fuel System Primary Filter/Water Separator Element - Replace

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

The fuel filter/water separator (if equipped) is not usually supplied by Perkins. The following text describes a typical fuel filter/water separator. Refer to the OEM information for further information on the fuel filter/water separator.

Turn the fuel supply valve (if equipped) to the OFF position before performing this maintenance. Place a tray under the fuel filter in order to catch any fuel that might spill. Clean up any spilled fuel immediately.

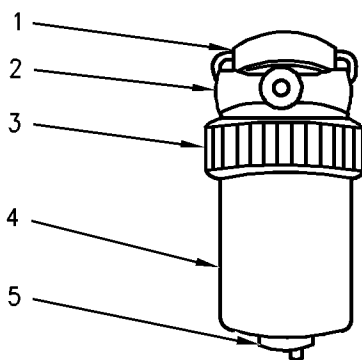


Illustration 42

g00802952

- (1) Cap
- (2) Fuel filter base
- (3) Quick release collar
- (4) Fuel filter
- (5) Drain valve for fuel filter

1. Close the fuel supply valve (if equipped).
2. Clean the outside of the fuel filter assembly. Open drain valve (5) and drain the fuel and water from fuel filter (4) into a suitable container.

Note: If the fuel filter element is not equipped with a drain, remove cap (1). Remove the nylon insert in order to reduce the level of fuel in the fuel filter element. A reduction in the level of fuel in the fuel filter element will help prevent fuel from being spilled when the element is removed.

NOTICE

Do not use a tool in order to remove the fuel filter. Attempting to remove the fuel filter with a filter wrench or a filter strap could damage the locking ring.

3. Hold fuel filter (4) and rotate quick release collar (3) counterclockwise. Remove quick release collar (3). The used element should be removed and discarded.

Note: If the element is equipped with a sediment bowl, remove the sediment bowl from the element. Thoroughly clean the sediment bowl. Inspect the O-ring seals. Install new O-ring seals, if necessary. Install the sediment bowl to the new element. Hand tighten the sediment bowl. Hand tightening is the only method that should be used.

NOTICE

Do not fill fuel filters with fuel before installing them. Contaminated fuel will cause accelerated wear to fuel system parts.

4. Ensure that the fuel filter base is clean. Push a new fuel filter fully into the fuel filter base.
5. Hold the fuel filter in place. Fit locking ring (3) into position. Rotate the locking ring clockwise in order to fasten the fuel filter to the fuel filter base.

Note: If the nylon insert was removed, install the nylon insert and install cap (1).

6. Open the fuel supply valve (if equipped).
7. Prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" for more information.

i01907683

Fuel System Secondary Filter - Replace

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

Turn the fuel supply valve (if equipped) to the OFF position before performing this maintenance. Place a tray under the fuel filter in order to catch any fuel that might spill. Clean up any spilled fuel immediately.

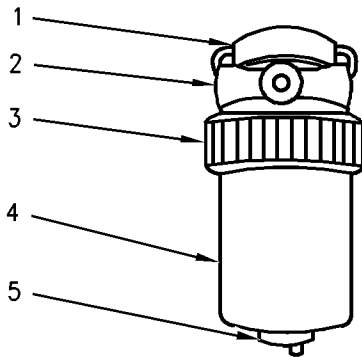


Illustration 43

g00802952

- (1) Cap
- (2) Fuel filter base
- (3) Quick release collar
- (4) Fuel filter
- (5) Drain valve for fuel filter

1. Close the fuel supply valve (if equipped).
2. Clean the outside of the fuel filter assembly. Open drain valve (5) and drain the fuel and water from fuel filter (4) into a suitable container.

Note: If the fuel filter element is not equipped with a drain, remove cap (1). Remove the nylon insert in order to reduce the level of fuel in the fuel filter element. A reduction in the level of fuel in the fuel filter element will help prevent fuel from being spilled when the element is removed.

NOTICE

Do not use a tool in order to remove the fuel filter. Attempting to remove the fuel filter with a filter wrench or a filter strap could damage the locking ring.

3. Hold the fuel filter (4) and rotate the quick release collar (3) counterclockwise. Remove the quick release collar (3). The used element should be removed and discarded.

NOTICE

Do not fill fuel filters with fuel before installing them. Contaminated fuel will cause accelerated wear to fuel system parts.

4. Ensure that the fuel filter base is clean. Push a new fuel filter fully into the fuel filter base.
5. Hold the fuel filter in place. Fit the locking ring (3) into position. Rotate the locking ring clockwise in order to fasten the fuel filter to the fuel filter base.

Note: If the nylon insert was removed, install the nylon insert and install the cap (1).

6. Open the fuel supply valve (if equipped).
7. Prime the fuel system. Refer to Operation and Maintenance Manual, "Fuel System - Prime".

i01907720

Fuel Transfer Pump Strainer - Clean

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

Cleaning the Strainer and the Sediment Chamber for the Fuel Transfer Pump

Turn the fuel supply valve (if equipped) to the OFF position before the maintenance is performed.

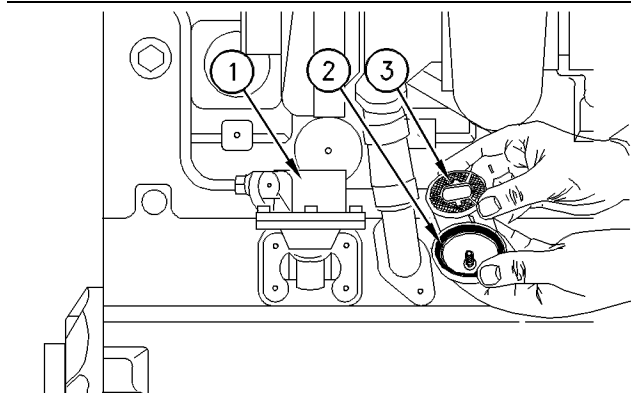


Illustration 44

g00286056

- (1) Fuel transfer pump
(2) Cover and seal
(3) Strainer

1. Remove the cover and seal (2) from the top of the fuel transfer pump (1). Remove the strainer (3).
2. Use nonflammable solvent in order to clean the strainer, the cover, and the seal. Carefully wash any sediment from the chamber of the fuel transfer pump.
3. Assemble the clean, dry fuel transfer pump.

NOTICE

Ensure that the lift pump cover is secure so that air does not enter the fuel system.

4. Turn the fuel supply valve (if equipped) to the ON position.
5. Prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" for more information.

i01907723

Hoses and Clamps - Inspect/Replace

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking

- Softness
- Loose clamps

Replace hoses that are cracked or soft. Tighten any loose clamps.

NOTICE

Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

Due to extreme temperature changes, the hose will harden. Hardening of the hoses will cause hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

Replace the Hoses and the Clamps

Refer to the Disassembly and Assembly Manual, "Oil Cooler - Remove and Oil Cooler - Install" for further information on removing and replacing the oil cooler hoses. Refer to the Torque Specifications Manual for further information on pipe fittings, hose clamps, and constant torque hose clamps.

i01907732

Refer to the OEM information for further information on removing and replacing fuel hoses (if equipped).

The coolant system and the hoses for the coolant system are not usually supplied by Perkins. The following text describes a typical method of replacing coolant hoses. Refer to the OEM information for further information on the coolant system and the hoses for the coolant system.

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine. Allow the engine to cool.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

Note: Drain the coolant into a suitable, clean container. The coolant can be reused.

3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
4. Remove the hose clamps.
5. Disconnect the old hose.
6. Replace the old hose with a new hose.

Note: For torques on hose clamps, see Torque Specifications Manual, "Torques for Standard Hose Clamps and Torques for Constant Torque Hose Clamps". Also refer to the OEM information for further information on torques for hose clamps.

7. Install the hose clamps with a torque wrench.

Note: For the proper coolant, see Operation and Maintenance Manual, "General Coolant Information and Coolant Recommendations".

8. Refill the cooling system. Refer to the OEM information for further information on refilling the cooling system.
9. Clean the cooling system filler cap. Inspect the cooling system filler cap's seals. Replace the cooling system filler cap if the seals are damaged. Install the cooling system filler cap.
10. Start the engine. Inspect the cooling system for leaks.

Radiator - Clean

The radiator is not usually supplied by Perkins. The following text describes a typical cleaning procedure for the radiator. Refer to the OEM information for further information on cleaning the radiator.

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the radiator for these items: Damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the radiator, if necessary.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction to the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the radiator fins. Slowly move the air nozzle in a direction that is parallel with the radiator tube assembly. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

If the radiator is blocked internally, refer to the OEM Manual for information regarding flushing the cooling system.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and the drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a “comb”. Inspect these items for good condition: Welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

i01907735

Severe Service Application - Check

Severe service is the application of an engine that exceeds the current published standards for that engine. Perkins maintains standards for the following engine parameters:

- Performance such as power range, speed range, and fuel consumption
- Fuel quality
- Operational Altitude
- Maintenance intervals
- Oil selection and maintenance
- Coolant type and maintenance
- Environmental qualities
- Installation

Refer to the standards for the engine or consult your Perkins dealer or your Perkins distributor in order to determine if the engine is operating within the defined parameters.

Severe service operation can accelerate component wear. Engines that operate under severe conditions may need more frequent maintenance intervals in order to ensure maximum reliability and retention of full service life.

Due to individual applications, it is not possible to identify all of the factors which can contribute to severe service operation. Consult your Perkins dealer or your Perkins distributor for the unique maintenance that is necessary for the engine.

The operating environment, improper operating procedures and improper maintenance procedures can be factors which contribute to a severe service application.

Environmental Factors

Ambient temperatures – The engine may be exposed to extended operation in extremely cold environments or hot environments. Valve components can be damaged by carbon buildup if the engine is frequently started and stopped in very cold temperatures. Extremely hot intake air reduces engine performance.

Quality of the air – The engine may be exposed to extended operation in an environment that is dirty or dusty, unless the equipment is cleaned regularly. Mud, dirt and dust can encase components. Maintenance can be very difficult. The buildup can contain corrosive chemicals.

Buildup – Compounds, elements, corrosive chemicals and salt can damage some components.

Altitude – Problems can arise when the engine is operated at altitudes that are higher than the intended settings for that application. Necessary adjustments should be made.

Improper Operating Procedures

- Extended operation at low idle
- Frequent hot shutdowns
- Operating at excessive loads
- Operating at excessive speeds
- Operating outside the intended application

Improper Maintenance Procedures

- Extending the maintenance intervals
- Failure to use recommended fuel, lubricants and coolant/antifreeze

i01907746

Starting Motor - Inspect

Perkins recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for proper operation. Check the electrical connections and clean the electrical connections. Refer to the Systems Operation, Testing and Adjusting Manual, "Electric Starting System - Test" for more information on the checking procedure and for specifications or consult your Perkins dealer or your Perkins distributor for assistance.

i01907737

Turbocharger - Inspect

Regular inspection and cleaning of the turbocharger compressor and turbocharger compressor housing is recommended. Periodic inspection and cleaning of the turbocharger turbine housing is also recommended. Any fumes from the crankcase are filtered through the air inlet system. Therefore, by-products from oil and from combustion can collect in the turbocharger compressor housing. Over time, this buildup can contribute to loss of engine power, increased black smoke and overall loss of engine efficiency.

If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel can cause additional damage to the pistons, the valves, and the cylinder head.

NOTICE

Turbocharger bearing failures can cause large quantities of oil to enter the air intake and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of oil into a turbocharger under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is renewed.

An inspection of the turbocharger can minimize unscheduled downtime. An inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

Note: Turbocharger components require precision clearances. The turbocharger turbine and compressor assembly must be accurately balanced due to high operational rpm. Severe Service Applications can accelerate component wear. Severe Service Applications require more frequent inspections of the compressor.

Removal and Installation

Note: The turbochargers that are supplied with 1106 engines are non-serviceable with the exception of the removal of the compressor cover in order to clean the compressor. However, a new O-ring must be installed when the compressor is reassembled.

For options regarding the removal, installation, repair and replacement, consult your Perkins dealer or your Perkins distributor. Refer to the Disassembly and Assembly Manual, "Turbocharger - Remove and Turbocharger - Install" for further information.

Cleaning and Inspecting

1. Remove the pipe from the turbocharger exhaust outlet and remove the air intake pipe to the turbocharger. Visually inspect the piping for the presence of oil. Clean the interior of the pipes in order to prevent dirt from entering during reassembly.
2. Gently turn the compressor wheel and the turbine wheel with a finger. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger must be renewed.
3. Remove the compressor cover. Check the compressor wheel for cleanliness. Check for the presence of oil. If oil is leaking from the back side of the wheel, there is a possibility of a failed turbocharger oil seal.

The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the intake air (plugged air filters), which causes the turbocharger to slobber.

4. Inspect the bore of the housing of the turbine outlet for corrosion.
5. Clean the turbocharger housing with standard shop solvents and a soft bristle brush.

6. Replace the compressor cover. Turn the compressor gently in order to check that the compressor turns freely and does not contact the compressor cover. Fasten the air intake pipe and the exhaust outlet pipe to the turbocharger housing.

i01914626

Valve Mechanism Cover Seal - Check

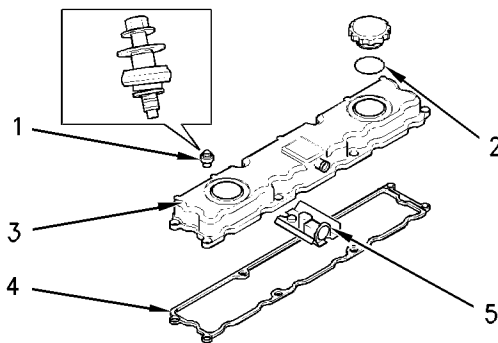


Illustration 45

g00882246

- (1) Securing bolts
- (2) O-ring for oil filler cap
- (3) Valve mechanism cover
- (4) Gasket
- (5) Breather assembly

1. Loosen the bolts (1) that secure the valve mechanism cover (3). The bolts will remain in place, held by the rubber gasket. Carefully remove the valve mechanism cover and check the surface of the rubber gasket (4) for any signs of damage. Remove the gasket from the recess in the valve mechanism cover and check the other side of the gasket for any damage.
2. Install a new gasket, if the gasket is damaged or distorted.
3. Install the valve mechanism cover. Refer to the Specifications Manual, "Valve Mechanism Cover" for the correct torque and the correct tightening sequence.

i01907741

Walk-Around Inspection

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections and trash buildup. Make repairs, as needed:

- The guards must be in the proper place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

NOTICE

For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

NOTICE

Accumulated grease and/or oil on an engine is a fire hazard. Remove the accumulated grease and oil. Refer to this Operation and Maintenance Manual, "Engine - Clean" for more information.

- Ensure that the cooling system hoses are properly clamped and that the cooling system hoses are tight. Check for leaks. Check the condition of all pipes.
- Inspect the water pump for coolant leaks.

Note: The water pump seal is lubricated by the coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of the water pump and the installation of water pump and/or seal, refer to the Disassembly and Assembly Manual, "Water Pump - Remove and Install" for more information or consult your Perkins dealer or your Perkins distributor.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the rocker cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps and/or tie-wraps.
- Inspect the piping for the air intake system and the elbows for cracks and for loose clamps. Ensure that hoses and tubes are not contacting other hoses, tubes, wiring harnesses, etc.
- Inspect the alternator belts and any accessory drive belts for cracks, breaks or other damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt is replaced, the belt will carry more load than the belts that are not replaced. The older belts are stretched. The additional load on the new belt could cause the belt to break.

- Drain the water and the sediment from the fuel tank on a daily basis in order to ensure that only clean fuel enters the fuel system.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges that are cracked. Replace any gauge that can not be calibrated.

Note: The water pump seal is lubricated by the coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and parts contract.

Visually inspect the water pump for leaks. Renew the water pump seal or the water pump if there is an excessive leakage of coolant. Refer to the Disassembly and Assembly Manual, "Water Pump - Remove and Install" for the disassembly and assembly procedure.

i01907756

Water Pump - Inspect

A failed water pump may cause severe engine overheating problems that could result in the following conditions:

- Cracks in the cylinder head
- A piston seizure
- Other potential damage to the engine

Warranty Section

Warranty Information

i01903596

Emissions Warranty Information

This engine may be certified to comply with exhaust emission standards and gaseous emission standards that are prescribed by the law at the time of manufacture, and this engine may be covered by an Emissions Warranty. Consult your authorized Perkins dealer or your authorized Perkins distributor in order to determine if your engine is emissions certified and if your engine is subject to an Emissions Warranty.

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Product and Dealer Information

Note: For product identification plate locations, see the section “Product Identification Information” in the Operation and Maintenance Manual.

Delivery Date: _____

Product Information

Model: _____

Product Identification Number: _____

Engine Serial Number: _____

Transmission Serial Number: _____

Generator Serial Number: _____

Attachment Serial Numbers: _____

Attachment Information: _____

Customer Equipment Number: _____

Dealer Equipment Number: _____

Dealer Information

Name: _____ Branch: _____

Address: _____

Dealer Contact

Phone Number

Hours

Sales: _____

Parts: _____

Service: _____
